U.S. Army Corps
of Engineers
Seattle District

Centralia Flood Damage Reduction Project
Chehalis River, Washington
Final General Reevaluation Report

Appendix D:
Economics

June 2003

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TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

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1. Introduction

1.1 PURPOSE

The purpose of this report is to document the economic evaluation of the Centralia Flood Damage Reduction Project, including flood inundation damages for the Chehalis and Skookumchuck rivers in and around the vicinity of the cities of Chehalis and Centralia and the town of Bucoda in Lewis and Thurston Counties, Washington.

1.2 AUTHORITY

Corps work in the Chehalis River Basin is specifically supported by the following Congressional actions:

Skookumchuck Dam Modification Project: Section 401(a) of 1986 Flood Control Act (PL 99-662) authorized construction of "works of improvement" substantially in accordance with the Report of the Chief of Engineers, dated 20 June 1984. The report was an interim report submitted (third in a series) under the Chehalis River and Tributaries Feasibility Study authority, originally authorized by a 19 April 1946 House of Representatives Flood Control Committee Resolution. The project recommended in that report envisioned modification of the existing, private, water supply dam on the Skookumchuck River to provide a maximum of 28,500 acre-feet (ac-ft) of flood storage, reducing flood damages in the Skookumchuck valley, the town of Bucoda, and the city of Centralia.

Chehalis River & Tributaries Study: On 9 October 1998, the U.S. House of Representatives Committee on Transportation and Infrastructure adopted Resolution 2581, requesting a review of past Corps report recommendations with a view to determining if the recommendations should be modified "with particular reference to flood control and environmental restoration and protection, including non-structural floodplain modification." This provides authority for the Corps to conduct a Flood Damage Reduction and Ecosystem Restoration Study for the Chehalis River Basin.

1.3 STUDY PROBLEM

The cities of Centralia and Chehalis have been subject to repeated flooding for many years. This flooding has caused extensive damage to private and public property and periodic closure of critical transportation routes resulting in significant economic losses. In closing transportation routes, the flooding also significantly disrupts emergency response by local governments, impacting public safety adversely. Without implementation of flood hazard reduction measures, actions, or projects, the area will continue to suffer from damaging floods. The local economy will continue to experience depressing economic effects due to the damages and uncertainty associated with future floods. In addition, stream habitat functions of the Chehalis River and its tributaries have been damaged in the past due to development throughout much of the Chehalis Basin. This has resulted in the diminishment of the remaining habitat resources to adequately support sustainable fish and wildlife resources. Loss of wetlands, riparian areas, and back channels has also contributed to some increased flooding in the area. The improvement of degraded areas along the Chehalis River or its tributaries can be a significant factor in sustaining and improving existing fish and wildlife resources in the Chehalis basin.

1.4 STUDY AREA

The Chehalis River Basin lies between the Deschutes River Basin on the east and the Cowlitz River Basin on the south, the Willapa Hills on the west, and the Olympic Range on the north (Figure 1). The basin includes parts of Lewis, Thurston, Cowlitz, Pacific, Grays Harbor, Mason, Jefferson, and Wahkiakum counties.

The Chehalis River Basin is the second largest river basin in the state of Washington outside the Columbia River Basin. The total drainage area of the Chehalis River Basin is 2,660 square miles of which approximately 85 percent is forestlands. Approximately 257 square miles (164,000 acres), or 9.7 percent of the basin is agricultural land.

The Chehalis River system is largely rain-fed with precipitation levels that range from 45 inches per year in the eastern Chehalis River valley to over 200 inches in the Olympic Mountains. Estimated average annual discharge of the entire basin is 11,208 cubic feet per second (cfs)[1].

The four major population centers, Chehalis, Centralia, Aberdeen, and Hoquiam, depend on surface waters of the basin for the largest portion of their municipal and industrial supplies. The principal industrial use of water is in the manufacturing of wood, pulp and paper products. Aberdeen's industrial water system supplies most of this water from the Wynoochee River, with the remainder from Lake Aberdeen.

Land within the basin is mostly forest cover with interspersed agricultural and residential areas. Forestlands are generally located on the upland areas with scattered amounts on bottomlands and constitute approximately 77 percent of the Upper Chehalis Basin (upstream of Porter) and 91 percent of the lower basin (downstream of Porter). Most forested acres are corporation-owned with the remainder being privately or government-owned (Capitol State Forest, Mount Baker-Snoqualmie National Forest and Olympic National Forest). Intensive agriculture and irrigation occur mostly in the low-lying valleys along the Chehalis River and its tributaries. Commercial farms in the basin are following national trends of increased acreage and reduced numbers. Primary use of agricultural land is for crop production (133,000 acres). Pasture comprises 1.8 percent, or 31,000 acres, of the basin (USDA 1975).

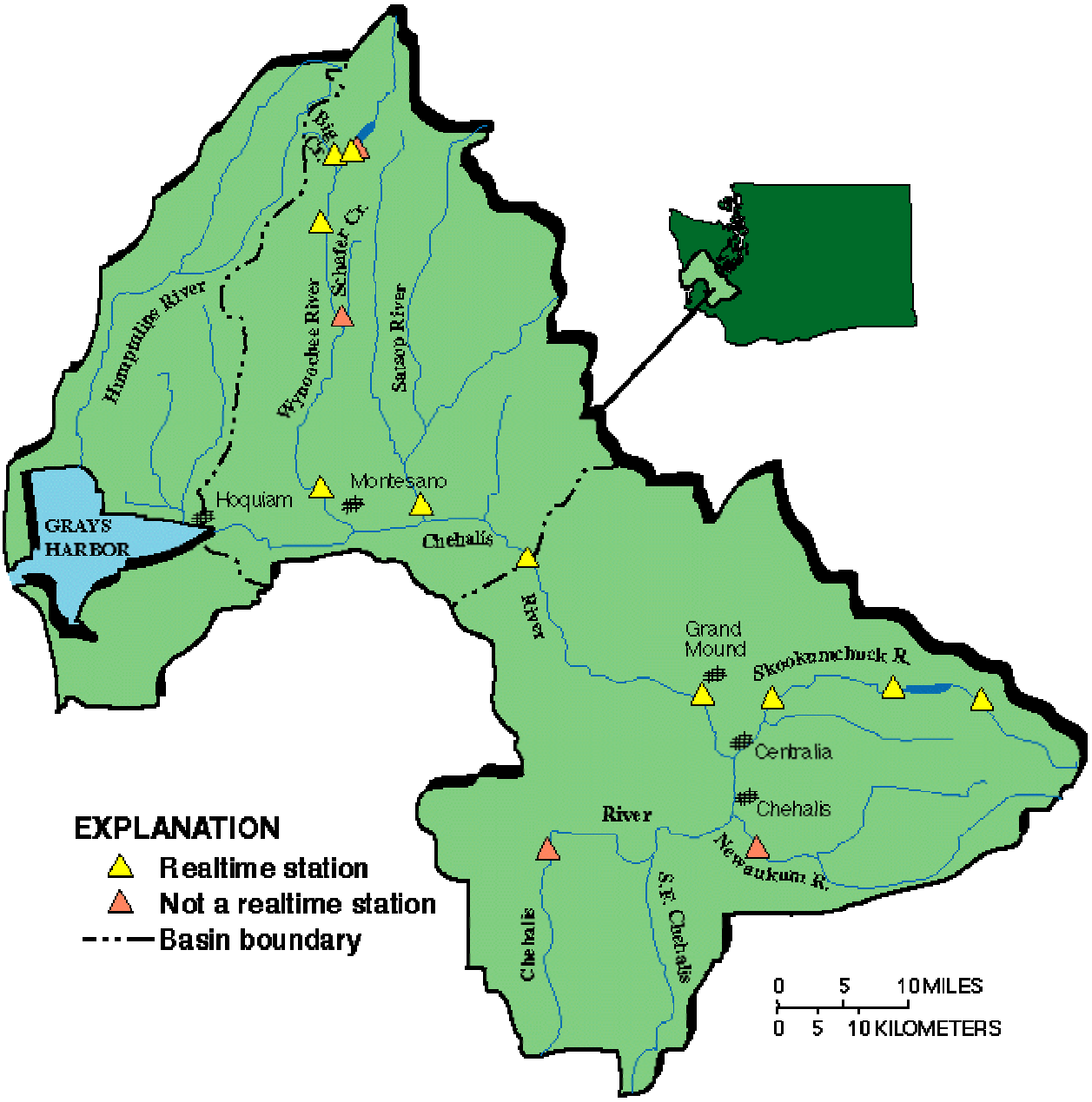
The anadromous fish resources of the basin are of national significance to sport, tribal, and commercial fishing and are important to the economy of the Chehalis Basin.

1.5 STUDY REACHES

The floodplain of the Chehalis and Skookumchuck rivers was broken into 12 reaches and 17 storage areas (see Plate 5 in the plates to the GRR; the plate does not include the town of Bucoda on the Skookumchuck or Skookumchuck River Reach 1). In addition to these areas, at the request of the local sponsor, a separable reach to cover China Creek has been included (Storage Area 610). At the present time, the analysis of potential damages in the China Creek area (Storage Area 610) has not been completed. As China Creek is separable from Chehalis and Skookumchuck rivers, omitting its potential inundation damages does not affect plan formulation for Chehalis or Skookumchuck, nor does it affect the general level of damages presented in this report.

[1] Chehalis River Council – http://www.crcwater.org/actplan/apbasovw.html

Figure 1: Chehalis River Basin



1.6 STUDY METHODOLOGY

The principal controlling guidance of the analysis comes from the U. S. Army Corps of Engineer's (the Corps, USACE) "Planning Guidance Notebook", ER 1105-2-100, with specific guidance from Appendix D – Economic and Social Considerations. Additional guidance on the risk-based analyses has been obtained from USACE's EM 1110-2-1619, dated 1 August 1996, "Engineering and Design - Risk-based Analysis for Flood Damage Reduction Studies." Guidance on agricultural damages has been derived from USACE Water Resources Support Center's "National Economic Development Procedures Manual – Agricultural Flood Damage," IWR Report 87-R-10, dated October 1987.

Procedurally, the damage assessment was conducted by employing HEC-FDA and HEC-EAD models. Structure and content data were first processed through an @RISK Excel spreadsheet to generate the appropriate stage/damage references with uncertainty for entry into the HEC-FDA model. This preliminary step was necessary due to the dependent relationships between structure damage and the damage categories of temporary relocation assistance, cleanup costs, and public assistance that cannot be modeled under HEC-FDA. The effects of this construction are that individual risk-based damage assessments are performed for each damage category external to the HEC-FDA model in a process that mimics the HEC-FDA methodology. Only the cumulative damage function is directly entered into the HEC-FDA model.

Without-project damages and with-project benefits are evaluated in the categories of: residential, commercial, and industrial inundation damages and flood cleanup costs; emergency costs; agricultural damages; and auto and rail transportation delays. The specific methodology employed in evaluating each category is explained including a description of key assumptions in the text provided for each category.

The Federal discount rate employed for this analysis is 6.125 percent with a price level of June 2002. The amortization period of the study is set at 50 years for all alternatives.

2. Floodplain Land Use and Associated Data Collection

2.1 Land Use and Structure Value

Land use was inventoried for the study area likely to be inundated by the 500-year flood event. A complete field survey of all commercial and industrial structures of the floodplain was undertaken. Residential structures were surveyed through a random sample of over 500 structures in the floodplain. Data collected included structure use, type of construction, structure size, condition, and first-floor elevation. A hand level was used to estimate elevations above ground level. The data was collected during the first half of FY01. Structure values are based on depreciated replacement value. Structure condition, use, type, and size were used in conjunction with the Marshall and Swift Valuation Service to develop estimates of depreciated replacement costs. First-floor elevation error and standard deviation for risk-based analyses are based on Table 6-5 of EM 1110-2-1619. Risk-based errors and standard deviations for residential depreciated replacement values are based on a triangular distribution with the upper and lower limits set at Marshall Valuation Service quality of construction grades at one grade above and one grade below, as discussed in Chapter 6-2 of EM 1110-2-1619.

2.2 Farm Budget and Crop Data

Agricultural crop acreage was developed with the assistance of the Cooperative Extension Office of Lewis County. Aerial mapping of agriculture allowed for the overlaying of floodplains to identify flooded agricultural acreage. Various crop budgets were obtained from the Cooperative Extension, Washington State University for northwest Washington. Historical crop yields and values for various floodplain crops were obtained from the U.S. Department of Agriculture, National Agricultural Statistics Service for Lewis County. Agricultural land restoration costs are based on previous USACE studies and farm budget reports. Monthly flood probabilities were derived based on the percentage of historical annual peak discharges occurring in each month at the U.S. Geological Survey's gauging station 12025000 Newaukum River near Chehalis. The probability of flood occurrence is shown in Table 1.

Table 1: Monthly Probability of Flood Occurrence

Month	Probability (%)
January	25.00
February	18.33
March	6.67
April	3.33
May	0.00
June	0.00
July	0.00
August	0.00
September	0.00
October	0.00
November	15.00
December	31.67

2.3 CONTENT VALUE

The risk-based content damage valuation and variation for each residential structure is based on the Economic Guidance Memorandum (EGM) 01-03, Generic Depth-Damage Relationships of 4 December 2000. As specified by the EGM, damage to content is a direct function of structure value, which no longer requires the specific determination of content value. Therefore, residential content value determinations were not calculated for the study. Further, the use of the generic depth-damage relationships waves the survey requirement as prescribed by ER 1105-2-100 Appendix E section E-19q (1). Non-residential content values were developed from the Lake Pontchartrain Hurricane Protection Plan Report of CH2M Hill, Inc., prepared for the New Orleans District of the USACE.

2.4 DEPTH PERCENTAGE DAMAGE CURVES

Residential structure and content damage functions employed for this study are contained in Economic Guidance Memorandum (EGM) 01-03, Generic Depth-Damage Relationships of 4 December 2000. The non-residential structural and content inundation damage curves utilized for the analysis are the Federal Emergency Management Agency (FEMA) National Flood Insurance Program's flood insurance rate review depth percent damage curves of 1998 for non-velocity zones. Agricultural damages have been assumed to be 100 percent based on conversations with County Agricultural Advisors for reasons of actual loss of crops and the non-marketability of the potentially surviving crops, except where noted in the analysis.

2.5 FLOOD DAMAGE MODEL

The flood damage analysis utilized the HEC-FDA model for the determination of expected annual flood damages. This model incorporates the principles of risk and uncertainty and evaluates project performance within the analysis. Economic damage inputs by category by reach and storage area to the HEC-FDA model were initially analyzed using Excel with @RISK at each floodplain hydraulic determination (2-, 5-, 10-, 25-, 50-, 100-, 200-, 500- and 1000-year as a general rule) to develop an overall "stage-damage" function by category by reach and storage area with error for the HEC-FDA model. An example of the @RISK spreadsheet is shown in Appendix A along with the hydrologic and hydraulic information employed in the HEC-FDA model. Appendix B lists the stage-damage functions without error and property inventories for the various reaches and storage areas developed for the study.

2.6 @RISK VARIABLES

The risk-based variables employed in the economic assessment of damages and their sources are listed in Table 2. Hydrologic and hydraulic uncertainty for the analysis is determined by the risk-based subroutines of the HEC-FDA model. Each different risk based parameter for each variable in Table 2 corresponds to a probability distributional function as defined in the at risk program.

TABLE 2: RISK-BASED PARAMETERS

Variable	Source	Risk-based Parameter
FFE - Residential	Survey	RiskTrigen (0.5,1.0, 4.5, 21.05, 95.00)
FFE - Nonresidential	Survey & EM 1110-2-1619	RiskNormal (0,0.1)
Residential Structure Size	Survey	RiskTnormal (1524, 524, 600, 4500)
Depreciated Replacement Value Structure	Survey & Marshall & Swift	RiskTriang (grade below, survey, grade above)
Temporary Relocation Assistance	FEMA	RiskTnormal (1537, 411, 0, 10000)
Public Assistance	FEMA	RiskTnormal (3.01, 2.36, 0, 20)
Cleanup Costs	Los Angeles Corps	RiskTnormal (3.65, 0.9375, 0, 10)

3. Floodplain Inventories and Damages

In the study area there were 3,926 residential units counted from base maps prepared by USACE. Marshall and Swift was used to determine the aggregate nominal depreciated structural value of approximately $383,517,000[2] that yields an average residential unit cost of $97,700. The average residential structure is approximately 1,550 square feet in size, which yields a depreciated square foot cost of approximately $63. The content value of these structures was not calculated, as the use of Economic Guidance Memorandum (EGM) 01-03 provides for the calculation of content damages directly from depreciated structural values. Residential structure count and value by location is shown in Table 3.

TABLE 3: RESIDENTIAL INVENTORY

CHEHALIS RIVER			SKOOKUMCHUCK RIVER		
Location	**Number**	**Structure Value**	**Location**	**Number**	**Structure Value**
Reach 1	208	20,319,000	Reach 1	35	3,419,000
Reach 2	52	5,080,000	Reach 2	26	2,540,000
Reach 3	98	9,574,000	Reach 3	383	37,415,000
Reach 4	365	35,656,000	Reach 4	619	60,469,000
Reach 5	123	12,016,000	Storage Area 701	4	391,000
Reach 6	272	26,571,000	Storage Area 702	76	7,424,000
Reach 7	40	3,908,000	Storage Area 703	118	11,527,000
Reach 7b	105	10,257,000	Storage Area 704	74	7,229,000
Storage Area 101	1	98,000	Storage Area 602	173	16,900,000
Storage Area 102	6	586,000	Storage Area 606	259	25,301,000
Storage Area 302	111	10,844,000	Storage Area 705	67	6,545,000
Storage Area 303	17	1,661,000	Storage Area 609	85	8,304,000
Storage Area 2	42	4,103,000			
Storage Area 3	38	3,712,000			
Storage Area 4	14	1,368,000			
Storage Area 5	251	24,520,000			
Storage Area 610B	264	25,790,000			
TOTAL	2007	196,063,000	TOTAL	1919	187,464,000

See Appendix A, Page A-7 for table showing linkages between storage areas and reaches.

As the hydrologic, hydraulic, and economic analyses are constructed on a risk-basis, determining the number of residential structures by flood event is not possible. However, by employing nominal frequencies and their associated nominal discharges and stages in relationship to the risk-based first floor of structures, mean flood inundated residential structure counts and the average level of inundation of the affected structures were derived as follows:

[2] All dollar values are expressed at an October 2002 price level.

Flood Event	Avg. Number of Residential Structures	Average Depth (ft)
1000-Yr	3324	3.3
500-Yr	2669	1.7
100-Yr	1561	0.8
50-Yr	1228	0.5
25-Yr	895	0.3
10-Yr	488	0.1

The survey of commercial and industrial structures indicates that within the study area there are 294 structures encompassing approximately 2,506,610 square feet with total depreciated valuations of $114,658,000 and $146,730,000 for structure and content, respectively. The location and valuations of these structures is given in Table 4.

TABLE 4: COMMERCIAL AND INDUSTRIAL INVENTORY

Location	Number	Structure Value	Content Value	Square Feet
CHEHALIS RIVER				
Reach 1	28	2,914,000	2,465,000	73,300
Reach 2	3	214,000	181,000	7,300
Reach 3	10	8,195,000	15,493,000	226,700
Reach 4	37	5,120,000	4,087,000	108,700
Reach 5	1	111,000	141,000	2,000
Reach 6	4	2,258,000	1,298,000	33,500
Reach 7	0	0	0	0
Reach 7b	2	332,000	322,000	5,200
Storage Area 101	0	0	0	0
Storage Area 102	0	0	0	0
Storage Area 302	7	2,788,000	3,165,000	57,700
Storage Area 303	0	0	0	0
Storage Area 2	31	16,640,000	25,337,000	384,800
Storage Area 3	30	12,297,000	13,005,000	262,200
Storage Area 4	52	28,277,000	42,101,000	657,200
Storage Area 5	6	3,016,000	4,715,000	40,900
Storage Area 610B	15	4,928,000	3,276,000	72,700
TOTAL	226	87,090,000	115,586,000	1,932,200
SKOOKUMCHUCK RIVER				
Reach 1	2	667,000	754,000	13,000
Reach 2	0	0	0	0
Reach 3	7	4,484,000	4,344,000	115,800
Reach 4	35	19,218,000	21,620,000	377,550
Storage Area 701	0	0	0	0
Storage Area 702	1	51,000	58,000	1,000
Storage Area 703	2	137,000	116,000	1,700
Storage Area 704	3	437,000	511,000	7,200
Storage Area 602	13	2,104,000	2,277,000	44,900
Storage Area 606	4	355,000	434,000	8,300
Storage Area 705	1	115,000	130,000	5,000
Storage Area 609	0	0	0	0
TOTAL	68	27,568,000	30,244,000	574,450

GRAND TOTAL	**294**	114,658,000	146,730,000	2,506,610

The location and valuation of public structures in the study area is presented in Table 5.

TABLE 5: PUBLIC INVENTORY

Location	Number	Structure Value	Content Value	Square Feet
CHEHALIS RIVER				
Reach 1	5	994,000	823,000	27,500
Reach 2	0	0	0	0
Reach 3	0	0	0	0
Reach 4	12	11,883,000	11,593,000	141,000
Reach 5	3	368,000	344,000	7,400
Reach 6	10	2,120,000	1,898,000	32,400
Reach 7	9	15,122,000	15,122,000	185,500
Reach 7b	1	196,000	47,000	2,500
Storage Area 101	0	0	0	0
Storage Area 102	0	0	0	0
Storage Area 302	0	0	0	0
Storage Area 303	0	0	0	0
Storage Area 2	13	1,472,000	1,657,000	60,900
Storage Area 3	55	6,716,000	3,705,000	193,400
Storage Area 4	0	0	0	0
Storage Area 5	1	263,000	263,000	3,000
Storage Area 610B	7	10,194,000	10,675,000	115,700
TOTAL	116	49,328,000	46,127,000	769,300
SKOOKUMCHUCK RIVER				
Reach 1	3	1,102,000	565,000	13,500
Reach 2	0	0	0	0
Reach 3	7	5,531,000	5,655,000	69,500
Reach 4	4	5,294,000	5,273,000	60,400
Storage Area 701	0	0	0	0
Storage Area 702	0	0	0	0
Storage Area 703	0	0	0	0
Storage Area 704	3	3,271,000	3,271,000	38,800
Storage Area 602	4	1,079,000	473,000	18,000
Storage Area 606	1	3,434,000	3,434,000	40,000
Storage Area 705	0	0	0	0
Storage Area 609	0	0	0	0
TOTAL	22	19,711,000	18,671,000	240,200
GRAND TOTAL	**138**	**69,039,000**	**64,798,000**	**1,009,500**

3.1 RESIDENTIAL INUNDATION DAMAGE

Residential flood inundation damages to structures referenced to the Chehalis River by event are shown in Table 6.

TABLE 6: CHEHALIS RIVER RESIDENTIAL INUNDATION DAMAGE BY EVENT

Flood Event	Structure	Content
25-year	8,487,000	4,949,000
50-year	14,072,000	8,117,000
100-year	19,552,000	11,187,000
500-year	50,953,000	28,297,000

Residential flood inundation damages to structures referenced to the Skookumchuck River by event are shown in Table 7.

TABLE 7: SKOOKUMCHUCK RIVER RESIDENTIAL INUNDATION DAMAGE BY EVENT

Flood Event	Structure	Content
34-year	4,709,000	2,826,000
50-year	6,362,000	3,785,000
88-year	9,086,000	5,349,000
143-year	12,753,000	7,479,000
320-year	18,783,000	10,853,000

3.2 RESIDENTIAL CLEANUP COSTS

Flooding not only causes damage to structures and contents but floodwaters present a significant cost in their aftermath clean up. Floodwaters leave debris, sediment and the dangers of diseases and mycotoxins throughout flooded structures. The cleaning of these structures is a necessary post-flood activity. Cleanup costs for the extraction of floodwaters, dry-out, and decontamination range from $1 to $4.75 per square foot, with a mean cost of $3.65 and standard deviation of $0.94 based on prior studies. Residential cleanup costs by location are shown in Table 8 and Table 9.

TABLE 8: RESIDENTIAL CLEANUP COSTS CHEHALIS RIVER BY EVENT

Flood Event	Cleanup Costs
25-year	2,976,000
50-year	4,377,000
100-year	5,510,000
500-year	9,481,000

TABLE 9: RESIDENTIAL CLEANUP COSTS SKOOKUMCHUCK RIVER BY EVENT

Flood Event	Cleanup Costs
34-year	2,139,000
50-year	2,672,000
88-year	3,454,000
143-year	4,657,000
320-year	5,853,000

3.3 EMERGENCY COSTS

ER 1105-2-100 states, "Flood damages are classified as physical damages or losses, income losses, and emergency costs." The ER then defines emergency costs as "those expenses resulting from a flood that would not otherwise be incurred…" The ER further requires that emergency costs should not be estimated by applying an arbitrary percentage to the physical damage estimates. As with all flood damage estimates and especially in the case of emergency costs, the potentials to double count damages are a distinct possibility and must be guarded against.

3.3.1 FEMA – Temporary Rental Assistance / Emergency Home Repairs

FEMA provides grants to assist individuals and families to find suitable housing when they are displaced in cases of federally declared disasters. This assistance, being directly attributable to the disaster and being an expenditure that would not be undertaken except for the disaster, falls clearly under the emergency costs guidance of ER 1105-2-100. Therefore, funds expended by FEMA for Temporary Rental Assistance or Funds for Minor Emergency Home Repairs (TRA) in the event of flooding are NED flood damages.[3]

Complying with ER 1105-2-100, an Internet database search of FEMA disaster reports for flood and storm damage was performed. Table 10 shows a compilation of the various FEMA reports related to flood and storm.

Table 11 shows the average per claim expenditure by FEMA for TRA ranged from $583 to $2,034 with an overall average expenditure of $1,537 per claim. The standard deviation of the average per claim expenditures is $411.

For risk-based modeling purposes it is assumed that TRA per claim expenditure is normally distributed with a mean of $1,537 and a standard deviation of $411.

[3] The component of TRA funds for minor emergency home repairs does present a potential double counting of structural damage; however, this component is relatively minor in comparison to rental assistance and is deemed insignificant to the overall level of damage or project justification.

TABLE 10: FEMA DISASTER RELIEF

Location	Date	Temporary Rental Assistance	Unemployment Assistance	Public Assistance	SBA Disaster Recovery Loans	Grants for Needs Unmet by Other Government or Voluntary Agencies
Andrew, Iron etc., MO	Apr-99	$328,233				$384,877
Madison County, MO	Apr-99				$374,000	
Kansas	Jan-99	$3,380,199		$1,196,242	$11,676,800	$2,459,248
Kansas & Missouri	Oct-98	$3,335,504			$1,806,700	$1,140,378
Kansas City, MO	Oct-98			$4,981,549		
Linn Co., MO	Oct-98			$116,762		
South, Central and Southeast Texas	Oct-98	$28,047,095	$427,324	$11,406,977	$88,443,500	$34,842,781
Washington	Oct-98			$1,600,000		
Southeast Texas	Sep-98	$4,190,165	$23,413	$5,267,342	$5,555,100	$2,209,979
Southwest Texas	Aug-98	$2,156,601	$65,817	$4,874,795	$6,450,000	$5,349,805
Wisconsin	Aug-98	$7,000,173			$3,508,400	$693,299
St. Louis City & County, MO	Jul-98	$1,300,000			$212,200	$440,491
Massachusetts	Jun-98	$5,400,000			$274,500	
Oregon	Jun-98	$215,294			$185,000	
North Carolina	Jan-98	$1,213,285		$7,187,159	$929,900	$306,987
North Dakota	Apr-97			$180,033,700		
California	1998	$22,000,000			$37,000,000	
Georgia	1998	$3,100,000		$29,300,000	$23,500,000	$1,800,000
Total		$81,666,549	$516,554	$245,964,526	$179,916,100	$49,627,845

TABLE 11: TRA AVERAGE EXPENDITURE

Location	Date	TRA Funds	TRA Claims	$ per Claim
Andrew, Iron etc., MO	Apr-99	$328,233	341	963
Kansas	Jan-99	$3,380,199	2,388	1,415
Kansas & Missouri	Oct-98	$3,335,504	3,762	887
South, Central and Southeast Texas	Oct-98	$28,047,095	13,786	2,034
Southeast Texas	Sep-98	$4,190,165	2,159	1,941
Southwest Texas	Aug-98	$2,156,601	1,445	1,492
Wisconsin	Aug-98	$7,000,173	5,221	1,341
St. Louis City & County, MO	Jul-98	$1,300,000	2,231	583
Massachusetts	Jun-98	$5,400,000	3,527	1,531
Oregon	Jun-98	$215,294	132	1,631
North Carolina	Jan-98	$1,213,285	703	1,726
California	1998	$22,000,000	15,000	1,467
Georgia	1998	$3,100,000	2,455	1,263
Total		$81,666,549	53,150	$1,537

3.3.2 FEMA – Public Assistance Program

FEMA will reimburse local and state governments and certain nonprofits up to 75 percent of eligible disaster response costs through the public assistance program. It includes all or parts of the following:

- Debris removal
- Emergency protective measures
- Road systems and bridges
- Water control facilities
- Public buildings and contents
- Public utilities
- Parks, recreational and other activities of a governmental nature

These costs, as well as the 25 percent contribution by local and state governments and the nonprofits, are eligible NED emergency costs under ER 1105-2-100. Again, care must be taken to make sure double counting does not occur between public assistance expenditures and structural or other damage categories.

Table 12 presents FEMA expenditures on Public Assistance (PA) to TRA expenditures. The HEC-FDA model is structured in such a fashion that, if a risk-based analysis of PA expenditures is to be made without an external direct input of a PA/stage damage function, PA expenditures must be converted to an individual structure basis. Total Public Assistance expenditures are, as shown in Table 12, 3.01 times the expenditures on TRA. On an individual disaster basis, PA expenditures range from zero to an unknown factor based on the FEMA reports, with the highest reported factor of 9.45. Applying the four standard deviation rule, common to other HEC-FDA variance protocols, the risked-based function of PA is a mean damage of 3.01 times the individual TRA expenditure with a normal deviate of a multiple of 2.36 bounded by zero damage.

TABLE 12: PUBLIC ASSISTANCE EXPENDITURES TO TRA EXPENDITURES

Location	Date	Public Assistance, $	TRA, $	TRA Claims	PA/TRA
Andrew, Iron etc., MO	Apr-99		328,233	341	0.00
Kansas	Jan-99	1,196,242	3,380,199	2,388	0.35
Kansas & Missouri	Oct-98		3,335,504	3,762	0.00
Kansas City, MO	Oct-98	4,981,549			-
Linn Co., MO	Oct-98	116,762			-
South, Central and Southeast Texas	Oct-98	11,406,977	28,047,095	13,786	0.41
Washington	Oct-98	1,600,000			-
Southeast Texas	Sep-98	5,267,342	4,190,165	2,159	1.26
Southwest Texas	Aug-98	4,874,795	2,156,601	1,445	2.26
Wisconsin	Aug-98		7,000,173	5,221	0.00
St. Louis City & County, MO	Jul-98		1,300,000	2,231	0.00
Massachusetts	Jun-98		5,400,000	3,527	0.00
Oregon	Jun-98		215,294	132	0.00
North Carolina	Jan-98	7,187,159	1,213,285	703	5.92
North Dakota	Apr-97	180,033,700			-
California	1998		22,000,000	15,000	0.00
Georgia	1998	29,300,000	3,100,000	2,455	9.45
Total		245,964,526	81,666,549		3.01

3.3.3 Summary of Emergency Costs

Emergency costs (temporary relocation and public assistance expenditures) by flood event and river are shown in Table 13 and Table 14.

TABLE 13: EMERGENCY COSTS – CHEHALIS RIVER

Flood Event	Temporary Relocation Assistance	Public Assistance
25-year	419,000	1,456,000
50-year	675,000	2,345,000
100-year	924,000	3,212,000
500-year	2,109,000	7,327,000

TABLE 14: EMERGENCY COSTS – SKOOKUMCHUCK RIVER

Flood Event	Temporary Relocation Assistance	Public Assistance
34-year	249,000	864,000
50-year	335,000	1,161,000
88-year	472,000	1,641,000
143-year	654,000	2,274,000
320-year	943,000	3,276,000

3.4 COMMERCIAL AND INDUSTRIAL INUNDATION DAMAGE

Within the study area there are 294 commercial and industrial properties with a total floor space of 2,506,610 square feet. The total nominal depreciated structure value of these properties is $114,658,000 with a total content value of $146,730,000. The average square footage cost of these structures is $46. Overall content-to-structure value ratio for these structures is 128 percent. Commercial and Industrial structure and content values by location are shown in Table 4: Commercial and Industrial Inventory.

Flood inundation damages to these structures by river and event are shown in Table 15 and Table 16.

TABLE 15: CHEHALIS COMMERCIAL AND INDUSTRIAL INUNDATION DAMAGE BY EVENT

Flood Event	Structure Damage	Content Damage
25-year	1,685,000	1,709,000
50-year	11,495,000	14,620,000
100-year	14,735,000	20,116,000
500-year	25,153,000	39,367,000

TABLE 16: SKOOKUMCHUCK COMMERCIAL AND INDUSTRIAL INUNDATION DAMAGE BY EVENT

Flood Event	Structure Damage	Content Damage
34-year	2,481,000	2,122,000
50-year	2,927,000	2,602,000
88-year	4,317,000	4,020,000
143-year	5,007,000	5,345,000
320-year	6,114,000	7,204,000

3.5 COMMERCIAL AND INDUSTRIAL CLEANUP COSTS

Commercial and industrial cleanup costs are limited to commercial and retail structures normally expected to engage with the public, e.g., restaurants, retail stores, office structures and other such businesses. Cleanup costs are not anticipated to occur with light industrial or other non-public commercial enterprises. Cleanup costs for commercial and industrial structures are presented in Table 17 and Table 18.

TABLE 17: CHEHALIS COMMERCIAL & INDUSTRIAL CLEANUP COSTS BY EVENT

Flood Event	Cleanup Costs
25-year	310,000
50-year	2,905,000
100-year	3,768,000
500-year	5,609,000

TABLE 18: SKOOKUMCHUCK COMMERCIAL & INDUSTRIAL CLEANUP COSTS BY EVENT

Flood Event	Cleanup Costs
34-year	461,000
50-year	481,000
88-year	643,000
143-year	1,004,000
320-year	1,022,000

3.6 PUBLIC INUNDATION DAMAGE

The study area contains 138 public structures whose locations are shown in Table 5: Public Inventory. These structures cover an area of 1,009,500 square feet and have a depreciated structural value of $69,040,000 or approximately $68 per square foot. The content-to-structure ratio is approximately 94 percent, yielding a content valuation of $64,798,000.

Flood inundation damages to these structures by river and event are shown in Table 19 and Table 20.

TABLE 19: CHEHALIS PUBLIC STRUCTURE INUNDATION DAMAGE BY EVENT

Flood Event	Structure Damage	Content Damage
25-year	537,000	359,000
50-year	3,965,000	3,267,000
100-year	4,978,000	4,050,000
500-year	10,239,000	9,836,000

TABLE 20: SKOOKUMCHUCK PUBLIC STRUCTURE INUNDATION DAMAGE BY EVENT

Flood Event	Structure Damage	Content Damage
34-year	1,188,000	1,364,000
50-year	1,621,000	1,684,000
88-year	1,767,000	1,975,000
143-year	2,989,000	2,837,000
320-year	3,453,000	3,788,000

Cleanup costs for public structures are presented in Table 21 and Table 22.

TABLE 21: CHEHALIS PUBLIC STRUCTURE CLEANUP COSTS BY EVENT

Flood Event	Cleanup Costs
25-year	16,000
50-year	379,000
100-year	422,000
500-year	1,398,000

TABLE 22: SKOOKUMCHUCK PUBLIC STRUCTURE CLEANUP COSTS BY EVENT

Flood Event	Cleanup Costs
34-year	132,000
50-year	242,000
88-year	258,000
143-year	397,000
320-year	543,000

3.7 INUNDATION DAMAGE SUMMARY

The tables (Tables 23 and 24) on the following page present a summary of the previously discussed damages.

TABLE 23: CHEHALIS RIVER STRUCTURAL DAMAGE SUMMARY

Flood Event	Residential			Commercial			Public					
	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
25-year	8,487,000	4,949,000	2,976,000	1,685,000	1,709,000	310,000	537,000	359,000	16,000	419,000	1,456,000	22,903,000
50-year	14,072,000	8,117,000	4,377,000	11,495,000	14,620,000	2,905,000	3,965,000	3,267,000	379,000	675,000	2,345,000	66,217,000
100-year	19,552,000	11,187,000	5,510,000	14,735,000	20,116,000	3,768,000	4,978,000	4,050,000	422,000	924,000	3,212,000	88,454,000
500-year	50,953,000	28,297,000	9,481,000	25,153,000	39,367,000	5,609,000	10,239,000	9,836,000	1,398,000	2,109,000	7,327,000	189,769,000

TABLE 24: SKOOKUMCHUCK RIVER STRUCTURAL DAMAGE SUMMARY

Flood Event	Residential			Commercial			Public					
	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	Total
34-year	4,709,000	2,826,000	2,139,000	2,481,000	2,122,000	461,000	1,188,000	1,364,000	132,000	249,000	864,000	18,535,000
50-year	6,362,000	3,785,000	2,672,000	2,927,000	2,602,000	481,000	1,621,000	1,684,000	242,000	335,000	1,161,000	23,872,000
88-year	9,086,000	5,349,000	3,454,000	4,317,000	4,020,000	643,000	1,767,000	1,975,000	258,000	472,000	1,641,000	32,982,000
143-year	12,753,000	7,479,000	4,657,000	5,007,000	5,345,000	1,004,000	2,989,000	2,837,000	397,000	654,000	2,274,000	45,396,000
320-year	18,783,000	10,853,000	5,853,000	6,114,000	7,204,000	1,022,000	3,453,000	3,788,000	543,000	943,000	3,276,000	61,832,000

4. Residential, Nonresidential, and Public HEC-FDA Model Results

The stage-damage functions presented in Appendix B were combined with the hydrology and hydraulic information of Appendix A into the HEC-FDA model for computation of the expected annual damages with uncertainty. The results of the HEC-FDA model are shown in Table 26: HEC-FDA Damages by Reach. Total expected annual damage on the Chehalis River is $6,590,730 and $2,254,190 for the Skookumchuck River. The relative damage by category is shown below in Table 25: Expected Annual Damage by Category for each river.

TABLE 25: EXPECTED ANNUAL DAMAGE BY CATEGORY

Category	Chehalis River		Skookumchuck River	
	$ Damage	Percentage	$ Damage	Percentage
Residential				
Structure	1,789,290	27.15	663,700	29.44
Content	1,036,310	15.72	394,210	17.49
Cleanup	588,290	8.93	278,600	12.36
Nonresidential				
Structure	1,002,610	15.21	352,340	15.63
Content	1,119,860	16.99	311,300	13.81
Cleanup	239,120	3.63	62,240	2.76
Public				
Structure	229,080	3.48	22,800	1.01
Content	189,360	2.87	15,290	0.68
Cleanup	24,490	0.37	4,270	0.19
TRA	83,250	1.26	33,380	1.48
PA	289,070	4.39	116,060	5.15
TOTAL*	6,590,730	100.00	2,254,190	100.00

*Total may not add due to rounding

Analysis is based upon 6.125% discount rate, 2002 price level, and 50-year period of analysis

TABLE 26: HEC-FDA DAMAGES BY REACH

Expected Annual Damage for the Without-project Condition (Damage in $1,000's)													
Stream	**Reach**	**Damage Categories (analysis is based upon 6.125% discount rate, 2002 price level, and 50-year period of analysis)**											
		Com - Cleanup	**Com - Cnt**	**Com - Str**	**PA**	**Res - Cleanup**	**Res - Cnt**	**Res - Str**	**TRA**	**Pub - Cleanup**	**Pub - Cnt**	**Pub - Str**	**Total**
Chehalis	Reach 7b	0.02	10.05	11.27	64.22	92.98	240.04	427.35	18.50	2.07	2.11	9.12	877.73
	Reach 7	0.00	0.00	0.00	1.68	4.96	5.86	9.74	0.48	5.26	19.20	23.41	70.59
	Reach 6	1.54	6.57	8.14	21.40	53.10	73.95	124.28	6.13	1.22	6.30	7.95	310.58
	Reach 5	0.00	0.00	30.19	2.72	7.19	9.77	16.37	0.80	0.11	2.06	2.44	71.65
	S610B	13.45	36.81	64.72	27.25	60.32	98.64	169.26	7.82	5.58	59.19	59.67	602.71
	Reach 4	3.58	37.07	40.78	25.01	55.65	92.68	159.20	7.26	1.80	11.65	13.27	447.95
	S3	13.01	67.14	62.87	3.29	4.95	14.40	26.13	0.95	7.93	65.13	93.83	359.63
	S4	61.81	344.33	216.17	1.09	1.66	4.06	7.21	0.31	0.00	0.00	0.00	636.64
	S5	1.43	13.83	8.14	10.73	13.08	45.47	82.75	3.09	0.11	0.95	0.80	180.38
	Reach 3	5.94	28.80	16.96	14.34	27.62	50.72	87.86	4.11	0.00	0.00	0.00	236.35
	Reach 2	25.73	54.28	96.08	23.26	47.63	79.87	137.11	6.62	0.00	0.00	0.00	470.58
	S2	26.45	195.95	125.52	2.76	3.87	11.88	21.51	0.80	0.33	22.12	16.35	427.54
	Reach 1	1.71	19.84	31.67	74.64	176.26	250.69	421.91	21.60	0.07	0.65	2.23	1001.27
	S101	0.00	0.00	0.00	0.58	1.04	2.20	3.70	0.10	0.00	0.00	0.00	7.62
	S102	0.00	0.00	0.00	2.09	4.13	7.69	13.37	0.65	0.00	0.00	0.00	27.93
	S302	84.44	305.20	290.11	10.05	27.41	34.69	57.58	2.86	0.00	0.00	0.00	812.34
	S303	0.00	0.00	0.00	3.95	6.45	13.68	23.97	1.15	0.00	0.00	0.00	49.20
Total Chehalis		*239.12*	*1119.86*	*1002.61*	*289.07*	*588.29*	*1036.31*	*1789.29*	*83.25*	*24.49*	*189.36*	*229.08*	*6590.73*
Skookumchuck	Reach 4	39.36	150.35	219.73	22.24	54.90	83.13	141.74	6.40	1.80	7.62	9.11	736.38
	SK-609	0.00	0.00	0.00	10.67	20.97	38.10	66.08	3.09	0.00	0.00	0.00	138.91
	Reach 3	18.44	143.21	113.68	43.71	111.39	146.07	243.32	12.52	0.00	0.00	0.00	832.34
	SK-602	0.35	1.96	2.25	1.93	5.90	6.37	10.29	0.56	0.13	0.48	0.65	30.87
	SK-606	0.01	0.02	0.02	1.32	3.99	4.42	7.15	0.38	1.10	4.81	6.65	29.87
	SK-705	0.00	3.19	3.40	1.19	4.85	4.32	6.78	0.35	0.00	0.00	0.00	24.08
	Reach 2	0.00	0.00	0.00	8.34	17.39	25.88	43.59	2.38	0.00	0.00	0.00	97.58
	SK-701	0.00	0.00	0.00	0.74	1.75	2.12	3.48	0.20	0.00	0.00	0.00	8.29
	SK-702	0.00	0.00	0.00	14.33	28.25	45.98	78.45	4.16	0.00	0.00	0.00	171.17
	SK-703	0.17	1.42	2.15	3.37	14.32	12.56	19.58	1.01	0.00	0.00	0.00	54.58
	SK-704	0.00	0.00	0.00	0.44	1.69	1.50	2.33	0.09	0.00	0.00	0.01	6.06
	Reach 1	3.92	11.14	11.10	7.80	13.21	23.76	40.91	2.24	1.24	2.38	6.38	124.08
Total Skookumchuck		*62.24*	*311.30*	*352.34*	*116.06*	*278.60*	*394.21*	*663.70*	*33.38*	*4.27*	*15.29*	*22.80*	*2254.19*
TOTAL ALL STREAMS		**301.36**	**1431.16**	**1354.95**	**405.13**	**866.89**	**1430.52**	**2452.99**	**116.63**	**28.76**	**204.65**	**251.88**	**8844.92**

5. Agricultural Flood Damages

The Planning Guidance Notebook of the USACE (ER 1105-2-100) has specific rules on the treatment of agricultural crops. Agricultural crops are divided into two categories. The first is basic crops and the second is other crops. Appendix E, Section E-20 b. states:

> *"(2) Basic and Other Crops.*
>
> *(a) Basic crops (rice, cotton, corn, soybeans, wheat, milo, barley, oats, hay, and pasture) are crops that are grown throughout the United States in quantities such that no water resources project would affect the price and thus cause transfers of crop production from one area to another. The production of basic crops is limited primarily by the availability of suitable land.*
>
> *(b) On a national basis, production of crops other than basic crops is seldom limited by the availability of suitable land. Rather, production is generally limited by market demand, risk aversion, and supply factors other than suitable land. Thus, production from increased acreage of crops other than basic crops in the project area would be offset by a decrease in production elsewhere. In some parts of the Nation analysis of local conditions may indicate that the production of other crops is limited by the availability of suitable land. (Suitable land is land on which crops can be grown profitably under prevailing market conditions.) In this case, crops other than basic crops listed above may also be treated as basic crops when measuring intensification benefits by farm budget analysis."*

The guidance provided indicates that the loss in income is only applicable to basic crops and that damages to other crops is limited to the variable costs (the direct production investment of IWR Report 87-R-10) prior to damage. These conventions are the basis of the current agricultural analysis.

With no change in cropping patterns anticipated, following the guidance of E-20 b. (3), benefits are restricted to damage reduction benefits.

Damage reduction benefits are the increases in net income due to the plan, as measured by farm budget analysis. These income increases may result from increased crop yields and decreased production costs. ER 1105-2-100 requires risk-based analysis in all flood damage reduction studies. This includes studies where primary damages occur to agricultural crops. The ER identifies key variables that could be incorporated into the risk-based analysis. The ER suggests such variables as hydrologic/hydraulic variables, the discharge associated with exceedance frequency, conveyance roughness, and cross-section geometry, may apply to agricultural studies. In the area of economic damages, the ER does not identify key factors of uncertainty related to the stage-damage relationship in agricultural studies. The ER suggests that key variables in agricultural areas may be the timing of flooding and cropping patterns. USACE districts are under no requirement to use the economic variables identified in the ER (structure first floor elevation, content and structure values) for agricultural damages or to perform explicit risk-based analysis of agricultural structures if they do not affect the formulation of the project. It is believed that the incorporation of a risk-based analysis would not have an effect on future plan formulation; a risk-based analysis of agricultural damages has not been performed.

5.1 AGRICULTURAL INVENTORY

The study area contains approximately 2,200 acres of agricultural lands that lie west of the Chehalis River and are subject to flooding from the Chehalis River. Three crops are listed as the principal for the study area, as shown in Table 27. Specific county farm budget data does not exist for these three crops; therefore, nearby proxy county data has been employed (Appendix C).

TABLE 27: STUDY AREA CROP HARVESTS – 1996

Crop	Acres	Percentage
Hay	1,320	60
Green Peas – Process	550	15
Sweet Corn – Process	330	25
Total	2,200	100

Source: Cooperative Extension Office – Lewis County

Agricultural acreage for the study is treated as having a composite crop based on the above three crops. The use of a composite crop was required because no formal survey of agricultural production by location was conducted. Agricultural production acreage and locations were ascertained through the use of an overlay of floodplain boundaries on aerial photography of agricultural production acreage.

5.2 TYPICAL FARM BUDGET EXAMPLE

Farm budgets were obtained from the Cooperative Extension, Washington State University. The monthly probability of flood occurrence was based on the occurrence of annual peak flow as measured at the USGS gauge 12025000 on the Newaukum River near Chehalis. These flood occurrence probabilities are:

TABLE 28: MONTHLY FLOOD PROBABILITIES

Month	Probability
January	25.00
February	18.33
March	6.67
April	3.33
May	0.00
June	0.00
July	0.00
August	0.00
September	0.00
October	0.00
November	15.00
December	31.67

The typical farm budget analysis employed for this analysis is shown in Table 29 for sweet corn. The calculation of the potential damage inundation will cause to sweet corn is shown in Table 30. The estimated effect of flood inundation for sweet corn, as well as for all other crops, is a 100 percent crop loss for all floods. This damage potential is based on the duration of flooding, from 2 to 5 days for all floods, flood depths, and the seasonal time of flooding and its effects on post-flood ground saturation duration.

TABLE 29: FARM BUDGET SWEET CORN

TABLE 1. SCHEDULE OF OPERATIONS AND ESTIMATED COSTS PER ACRE
1990 SWEET CORN PRODUCTION COSTS
NORTHWEST WASHINGTON 50 ACRES ON 250 ACRE FARM

OPERATION	TOOLING	MTH	YEAR	MACH HOURS	LABOR HOURS	TOTAL FIXED COST	VARIABLE COST: FUEL, LUBE, & REPAIRS	VARIABLE COST: MACH LABOR	VARIABLE COST: SERVICE	VARIABLE COST: MATER.	VARIABLE COST: INTER.	TOTAL VARIABLE COST	TOTAL COST
						$	$	$	$	$	$	$	$
DISK	130HP, 15' DISK	OCT	1989	.14	.17	6.02	3.68	1.50	.00	.00	.52	5.70	11.72
SUBSOIL	130HP, SUBSOILER	OCT	1989	.39	.48	15.10	7.14	4.28	.00	.00	1.04	11.46	26.56
DISK	130HP, 15' DISK 2X	MAR	1990	.28	.33	12.04	7.36	2.99	.00	.00	.52	10.87	22.92
LIMING	CUST LIMING, INCL. 1T LIME	MAR	1990	.00	.00	.00	.00	.00	23.00	.00	1.15	24.15	24.15
PLOW	130HP, 4-16 PLOW	MAR	1990	.39	.47	18.62	9.45	4.21	.00	.00	.68	14.34	32.97
FERTILIZE	CUSTOM FERT. APPLICATION[1]	APR	1990	.00	.00	.00	.00	.00	5.25	24.34	1.18	30.77	30.77
CULTIMULCH	130HP, 13' CULTIMULCHER	APR	1990	.16	.19	5.58	2.71	1.73	.00	.00	.18	4.62	10.20
WEED CONTROL	WEED CONTROL 60HP[2]	APR	1990	.38	.46	14.93	1.86	4.16	.00	23.63	1.19	30.84	45.77
PLANT	CUSTOM PLANTING[3]	APR	1990	.00	.00	.00	.00	.00	15.00	89.00	4.16	108.16	108.16
CULTIVATE	60HP,4R CULTIVATOR	MAY	1990	.18	.22	7.80	.90	2.00	.00	.00	.09	2.98	10.78
FERTILIZE	60HP,CULTVTR/FERT ATT.[4]	JUN	1990	.21	.25	10.41	1.28	2.29	.00	24.00	.55	28.12	38.53
HARVEST	BY PROCESSOR	AUG	1990	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
PICKUP TRUCK	USED, THIS CROP	ANN	1990	.00	.00	.00	.00	.00	18.80	.00	1.13	19.93	19.93
LAND RENT	LAND RENT	ANN	1990	.00	.00	150.00	.00	.00	.00	.00	.00	.00	150.00
OVERHEAD	5% VARIABLE COST	ANN	1990	.00	.00	.00	.00	.00	14.60	.00	.00	14.60	14.60
TOTAL PER ACRE				2.13	2.57	240.50	33.38	23.16	76.65	160.98	12.38	306.55	547.05

[1] 220 LB/AC 0-0-60; 6 LB/AC ZINC.
[2] .5 GAL/AC SURPASS 6.7E; .375 GAL/AC ATRAZINE 4L.
[3] BAND APPLICATION OF 300 LB/AC 18-46-0.
[4] 200 LB/AC AMMONIUM NITRATE.

TABLE 30: SWEET CORN WEIGHTED LOSS CALCULATION

Sweet Corn												
Yield	6.5 tons											
Flood Probability	0.00	0.00	15.00	31.67	25.00	18.33	6.67	3.33	0.00	0.00	0.00	0.00
Month	9	10	11	12	1	2	3	4	5	6	7	8
Variable Cost	0.00	38.28	0.00	0.00	0.00	0.00	80.04	194.90	10.78	38.53	0.00	0.00
Cumulative Cost	0.00	38.28	38.28	38.28	38.28	38.28	118.32	313.22	324.00	362.53	362.53	362.53
Weighted Loss	0.00	0.00	5.74	12.12	9.57	7.02	7.89	10.43	0.00	0.00	0.00	0.00
TOTAL LOSS	$52.77											

Through similar farm budget analyses, the per-acre damage has been determined at the following values for the crops of the study area.

TABLE 31: PER ACRE CROP DAMAGE

Crop Type	Per Acre Damage	Weight	Weighted Loss
Hay	$220.48	60%	$132
Corn	$52.77	25%	$13
Peas	$61.60	15%	$9
Total per acre loss			$155

5.3 RESTORATION OF FIELD CROPLAND AFTER FLOODING

The requirement to restore agricultural land after having been inundated by flood will necessitate the reworking of fields at twice the level of normal land preparation and an the application of additional cycles of fertilizer, weed control, and pest control, based upon consultation with the Lewis County Farm Advisor. This level of requirement is consistent with the post-flood demands identified in other USACE studies. The estimated net cost for agricultural land restoration on a per acre basis is presented in Table 32.

TABLE 32: PER ACRE FIELD CROPLAND RESTORATION COSTS

Operation	$ Cost/per Acre
Disc (4 times)	60.00
Subsoil	9.00
Chisel Field (2 times)	15.00
Landplane (2 times)	24.00
Fertilize	64.00
Weed Control	45.00
Pest Control	26.00
Total	$243.00

In addition to restoration costs, it is assumed that post-flood cleanup of debris and other matter will cost $20 per acre for all agricultural land.

5.4 AGRICULTURAL FLOOD DAMAGES

Agricultural damages by flood event are shown in Table 33.

TABLE 33: AGRICULTURAL DAMAGES BY FLOOD EVENT

Flood Event	Crop Damage	Land Restoration	Cleanup	Total
6-year	52,000	82,000	6,000	140,000
10-year	227,000	356,000	29,000	612,000
100-year	341,000	534,000	44,000	919,000
500-year	341,000	534,000	44,000	919,000

Expected annual agricultural damages were calculated using HEC-EAD. The results of the HEC-EAD model for agricultural damages are shown in Table 34.

TABLE 34: EXPECTED ANNUAL AGRICULTURAL DAMAGE

Category	Expected Annual Damage
Crop Damage	42,930
Land Restoration Costs	67,420
Cleanup Costs	5,500
Total	115,850

6. Transportation Related Damages

Chehalis River flooding presents a serious threat to interstate commerce. Past floods have necessitated the closure of I-5 to vehicle traffic, as well as the closures of two major railroad lines (Burlington Northern Santa Fe and Union Pacific Railroads). The costs associated with travel delays, diversion costs, and cleanup costs are valid project concerns on a National Economic Development (NED) basis. The following sections explore these transportation related damages.

6.1 I-5 DAMAGES

Mapping of the floodplains indicates that flooding will make I-5 subject to closure between Centralia and Chehalis from floods. This mapping also indicates that a diversion around the floodplain will be required. However, this diversion will be quite lengthy, approximately 101 miles. The diversion, going southbound, involves leaving I-5 at the junction with SR-507 traveling northeast to Yelm, transitioning to SR-702 east and proceeding to SR-7; then proceeding southward on SR-7 for approximately 35 miles to Morton where a connection to U.S.-12 westbound is taken to return to I-5. Northbound traffic would reverse the route.

The estimate of the traffic count involved in the diversion is taken from the Washington State Department of Transportation's (WSDOT) Trips System for 2000. Average total daily through traffic between state route milepost 81.21 (before ramp SR 507) and milepost 68.94 (after ramp SR-12) Bow Hill Road is estimated at 51,000. In the immediate vicinity of the cities of Chehalis and Centralia average daily volume reaches approximately 62,000, but this added traffic is assumed to not leave the area. The affected daily traffic for the analysis is a base flow traffic rate of 51,000. Further, the analysis employs the Trips System indication that 12 percent of the traffic is truck, as measured by the Bow Hill Road indicator; the nearest indicator maintained by WSDOT that monitors vehicle mix.

The analysis of transportation delays and costs was carried forward by employing the procedure in ER 1105-2-100, Appendix D and as shown in Table D-4: Value of Time Saved by Trip Length and Purpose, in that appendix, with a measure of median household income for Lewis County of $32,557 (1997 U.S. Bureau of the Census). A per-vehicle passenger rate of 1.15 is assumed for the analysis. The diversion is estimated to take 3.16 hours, assuming a 32 mph diversion speed. Mileage rates are further assumed to be 34.5 and 48 cents for cars and truck, respectfully. The above factors yield a total daily cost of delay of $3,394,986 according to the guidelines of ER 1105-2-100, as shown in Table 35: I-5 Flood Related Damages.

Average Daily Total thru Traffic	51000		
Trucks	6120		
Cars	44880		
Median Family Income	$32,557		
Avg. Hourly Rate	15.65		
Value of Time (53.8%)	8.42		
Vehicle Operation Costs	Per Mile		
Truck	0.480		
Car	0.345		
	Miles	MPH	Time/hrs
Diversion	101	32	3.16

TABLE 35: I-5 FLOOD RELATED DAMAGES

	Value of Time $/hr	Occupancy Factor	Occ. Weighted VOT	Time Costs	Diversion Mileage Cost	Total Cost per Vehicle	Vehicle Units	Daily Costs		
								Time	Mileage	Total
Cars	8.42	1.15	9.68	$30.57	$34.85	$65.41	44880	$1,371,783	$1,563,844	$2,935,627
Trucks	8.42	1	8.42	$26.58	$48.48	$75.06	6120	$162,662	$296,698	$459,360
TOTAL								$1,534,445	$1,860,541	$3,394,986

Transportation delay costs due to flood impacts are shown in Table 36: I-5 Damages by Flood Event based on estimated closure durations for flooding and cleanup for Chehalis-Centralia area.

TABLE 36: I-5 DAMAGES BY FLOOD EVENT

Flood Event	I-5 Closure in Days	Total Cost
25	0	$0
50	4	$13,579,945
100	4.5	$15,277,438
200	5	$16,974,931
500	6	$20,369,917

Applying these flood related values to the HEC-EAD model yields an estimate of equivalent annual damage of $476,300. Average annual damages in this category for the period until I-5 would be elevated in the without-project condition (2012) is $129,100.

6.2 RAIL FREIGHT FLOOD IMPACTS

The basis for the examination of NED costs from rail disruptions is the Pharos Corporation's "Chehalis River Flood Reduction Project" study of 2001, prepared for Lewis County. The study reports that the Burlington Northern Santa Fe Railway (BNSF) owns and operates the rail line running north and south within the Chehalis floodplain. This double main-line track parallels I-5 within the floodplain and continues south to Eugene, Oregon, where it connects with the Union Pacific Railroad (UPRR). BNSF traffic typically ranges from 30 to 40 trains per day, and is primarily composed of grain for export; forest products imported from Canada; and domestic shipments of metals and minerals, coal, chemicals, automobiles and consumer goods.

The second major rail service connected to the study area is the UPRR. Although UPRR lines do not run directly within the floodplain, UPRR, by way of trackage rights, operates trains over BNSF track in the Chehalis corridor to access and route shipments to many of their western Washington rail customers. The number of UPRR trains utilizing the Chehalis corridor is 18 to 20 trains per day.

Based on annual reports published by BNSF and UPRR and assuming a per rail car carrying weight of 268,000 pounds, the estimated daily rail car transit rate is 1,230 in the Chehalis corridor. In the event of a prolonged rail outage, these rail lines may be forced to reroute traffic via routes in either Pasco or Spokane, Washington. The shortest alternate route bypassing the Chehalis floodplain would increase trip mileage by 350 miles. BNSF estimates that the average mileage payout for equipment rent/car ownership at approximately $0.40 per mile. Given the mileage increase of the shortest alternate route, the additional cost per railcar diverted equals $140.00 or $172,200 per day for all railcars being diverted.

Furthermore, depending on the alternate line's available capacity, the rerouted cars would likely be subject to a minimum of 48 hours of extended transit time for the additional 350-mile trip. Estimating from the 1999 primary carriers annual reports, the approximate average daily equipment expense per railcar is $23.30. On an estimated daily volume of 1,230 railcars the rail lines would incur additional daily equipment expenses totaling $28,659.

Potential flood related operation and equipment expenses to the rail lines by flood event are shown below in Table 37: Railroad Damages by Flood Event.

TABLE 37: RAILROAD DAMAGES BY FLOOD EVENT

Flood Event	Duration	Railcars Effected	Reroute Expenses	Equipment Expenses	Total
50-year	4	4920	688,800	229,272	918,072
100-year	4.5	5535	774,900	257,931	1,032,831
200-year	5	6150	861,000	286,590	1,147,590
500-year	6	7380	1,033,200	343,908	1,377,108

Railroad damages were modeled in HEC-EAD to estimate expected annual damages. Applying a 25-year non-damaging event to the HEC-EAD model yields expected annual damage for railroads of $32,200.

6.3 AVOIDED COST OF I-5 WIDENING

The project purpose of the Centralia, Washington, Flood Damage Reduction PED Study is to reduce flood hazards and flood damage costs in the project area to the maximum extent practicable. In addition to providing flood protection to thousands of homes and hundreds of businesses, the project will also reduce inundation to I-5 in the Chehalis-Centralia area. This highway has been particularly susceptible to inundation in the project area historically, and has been shut down twice in the last 10 years with floodwater up to 8 feet in depth over the roadway (closed for 4 days in 1996, and 1 day in 1990).

Due to safety issues and the tremendous economic impacts associated with I-5 closures, WSDOT is on record as stating that I-5 will require raising to above the 100-year flood elevation at the same time as other federally mandated widening and upgrading is accomplished. The incremental costs of raising the freeway under the without-project condition has been estimated by WSDOT at $44 million. Their detailed engineering cost estimates are presented in Appendix D to this appendix. If the Recommended Plan turns out to provide at least 100-year protection to this section of I-5, the incremental costs of raising the freeway would not need to be expended. Under this scenario, the avoided cost can be included as an NED benefit. The construction timing used in the economic analysis was based on correspondence received from WSDOT.

Construction sequencing and timing assumptions were based on expected legislative funding streams that run from 2006 to 2012. The Corps conservatively chose to discount all construction costs from year 2012. A copy of WSDOT's letter that addresses construction timing can also be found in Appendix D to this appendix.

7. Expected Annual Damage Results

Table 38 summarizes the expected annual damages from flooding along the Chehalis and Skookumchuck rivers developed by the preceding analyses.

TABLE 38: EXPECTED ANNUAL DAMAGE SUMMARY

Damage Category	Expected Annual Damage
Structures	4,059,810
Contents	3,066,330
Cleanup	1,197,010
Temporary Relocation Assistance	116,630
Public Assistance	405,130
Agriculture	115,850
I-5 Delays	129,100
Railroad Delays	32,200
Total	**$9,122,060$**

8. With-project Economic Analysis

A risk-based analysis as previously described was performed for each alternative measure of the final preliminary array to determine residual damages and project performance. The with-project HEC-FDA conditions for each measure were modeled by modifying the existing hydraulic condition input data according to the results of the UNET modeling results. For example, if a particular discharge-frequency or stage-discharge function was altered as a result of a particular measure (levee, bypass, or reservoir), the appropriate without-project data set was modified and HEC-FDA re-run to calculate residual damages, damage reductions, and the performance of the alternative. Data on hydraulic performance is found in the body of the GRR.

8.1 FINAL ALTERNATIVES

An initial array of alternatives was formulated and screened by preliminary screening criteria. The resultant set of final alternatives was evaluated using the HEC-FDA risk-based economic model. The full array of preliminary final alternatives is presented below.

TABLE 39: FINAL ALTERNATIVES

ALTERNATIVE	CONFIGURATION	DESCRIPTION
Alternative 1		**No Action Alternative**
Alternative 2		**Skookumchuck Dam Modifications Alternative**
	SKDam1	Dam modification alternative 2.b.2 without pool raise
	SKDam2	Dam modification alternative 2.b.2
	SKDam	Existing dam
Alternative 3		**Overbank Excavation and Flowway Bypass Alternative**
	Bypass-SkDam2	Bypass 3.a with dam modification alternative 2.b.2
	Bypass-SkDam1	Bypass 3.a with dam modification alternative 2.b.2 without pool raise
	Hybrid-SkDam1	Modified bypass with levee alternative with dam modification alternative 2.b.2 without pool raise
	Hybrid-SkDam2	Modified bypass with levee alternative with dam modification alternative 2.b.2 with pool raise
Alternative 4		**Levee System Alternative**
	CheLev2-SkDam	Chehalis River, Salzer Creek, Dillenbaugh Creek modified levee design to 100-yr performance level with existing Dam
	CheLev2-SKDam1	Chehalis River, Salzer Creek, Dillenbaugh Creek levee design to 100- yr performance level with SKDam1
	CheLev2-SKDam2	Chehalis River, Salzer Creek, Dillenbaugh Creek levee design to 100-yr performance level with SKDam2
	CheLev2-ExSkDam/SkLev	Chehalis River, Salzer Creek, Dillenbaugh Creek levee design to 100-yr performance level with existing dam and Skookumchuck levees
	CheLev2-SkDam1/SkLev	Chehalis River, Salzer Creek, Dillenbaugh Creek levee design to 100-yr performance level with SKDam1 and Skookumchuck Levees
	CheLev2-SkDam2/SkLev	Chehalis River, Salzer Creek, Dillenbaugh Creek levee design to 100-yr performance level with SKDam2 and Skookumchuck Levees

ALTERNATIVE	CONFIGURATION	DESCRIPTION
Alternative 7		**Interagency Alternative**
	Alternative 7-existing Dam	All structural features without I-5 raise and with levees with existing dam
	Alternative 7-SkDam1	All structural features without I-5 raise and with levees with low pool dam
	Alternative 7-SkDam1	All structural features without I-5 raise and with levees with high pool dam

8.2 Estimated Costs of Final Alternatives

Preliminary cost estimates developed during Phase 1 were refined for all final Phase 2 alternatives. The cost estimates were developed to include: 1) Construction Costs, 2) Real Estate Costs, 3) Operation and Maintenance Costs, and 4) Mitigation Costs. These cost estimates (in average annual figures) are presented in Table 40.

8.3 Risk-Based Assessment and Evaluation of Final Alternatives

The following paragraphs describe the RBA results for both damages reduced and project performance for each measure and combination of alternatives. The analysis results are presented in Table 40, and described in the following paragraphs.

8.4 Residual Damages, Damages Reduced and Net Benefits

8.4.1 Chehalis River Measures

The Chehalis River Levee measures, as the first alternative element, were evaluated using the existing Skookumchuck Dam operation. The HEC-FDA results for residual damages are presented in Table 40. Table 40's Other Damages Reduced includes transportation delays, agricultural damages, and the avoided cost savings from not raising I-5 during its scheduled modification as described in Section 6.3. Table 40 indicates only three of the five general alternative plans presented have a likelihood of meeting NED criteria. These three general plans are: (1) CheLev2, (2) Hybrid Plan, and (3) CheLev2–SKLev (in Table 40 nomenclature). Each of these general plans may or may not contain a Skookumchuck Dam modification. The two general plan types that can be ruled out as potentially producing a NED candidate are Bypass and Alternative 7. These two general plan types are ruled out for further analyses by their negative net NED benefits showing at this level of plan formulation. The Hybrid Plan general plan type is also eliminated from further analyses at this time given the disparity in net NED benefits in comparison to the other two general plan types. Although the Hybrid Plan type shows positive net NED benefits, it is unlikely that this plan type could close the annual benefit difference of $324, given the level of feature overlap between the general plan types.

The general plan type with the highest net benefit is ChevLev2 with a net annual benefit range of $1,677 to $2,699. With the difference between the two remaining general plan types only being levees on the Skookumchuck River and the general plan type with these levees (ChevLev2–SKLev) showing incremental justification, the remaining analyses focuses on this general plan type.

TABLE 40: PHASE 1 WITH-PROJECT ECONOMIC ANALYSIS

Alternative	Expected Annual Damages					Flood Damages Reduced	Other Damages[1]	Other Damages Reduced	Total Damages Reduced	Cost	Net Benefit	B/C
	Chehalis		Skook		Total							
	Res/Comm	Public	Res/Comm	Public								
No Action	6147.81	442.93	2211.84	42.36	8844.94	0.00	2239.10	0.00	0.00	0.00	0.00	0.00
CheLev2 - Existing SkDam	2347.19	82.95	2392.52	46.94	4869.60	3975.34	2239.10	2239.10	6214.44	4537.06	1677.38	1.37
CheLev2 - SkDam 1	2081.67	70.05	595.59	15.34	2762.65	6082.29	2239.10	2239.10	8321.39	5622.75	2698.64	1.48
CheLev2 - SkDam 2	2057.19	68.37	504.68	10.57	2640.81	6204.13	2239.10	2239.10	8443.23	5839.89	2603.34	1.45
CheLev2SR6 - Ex SkDam	2186.09	58.63	2290.11	42.72	4577.55	4267.39	2239.10	2239.10	6506.49	4863.89	1642.60	1.34
CheLev2SR6 - SkDam 1	1893.35	45.85	694.59	14.09	2647.88	6197.06	2239.10	2239.10	8436.16	5949.58	2486.58	1.42
CheLev2SR6 - SkDam 2	1876.98	43.86	498.56	10.30	2429.70	6415.24	2239.10	2239.10	8654.34	6166.72	2487.62	1.40
Hybrid Plan - Existing Dam	2231.15	61.06	1363.55	38.16	3693.92	5151.02	2239.10	2239.10	7390.12	5098.44	2291.68	1.45
Hybrid Plan - SkDam 1	1901.64	47.66	562.03	14.14	2525.47	6319.47	2239.10	2239.10	8558.57	6184.14	2374.43	1.38
Hybrid Plan - SkDam 2	1900.60	45.02	464.71	8.85	2419.18	6425.76	2239.10	2239.10	8664.86	6401.28	2263.58	1.35
CheLev2 - Ex SkDam/SKLev	2217.91	60.56	1677.61	42.06	3998.14	4846.80	2239.10	2239.10	7085.90	4865.90	2220.00	1.46
CheLev2 - SkDam 1/SkLev	1932.99	50.86	453.78	11.19	2448.82	6396.12	2239.10	2239.10	8635.22	5951.60	2683.62	1.45
CheLev2 - SkDam 2/SkLev	1924.27	48.05	337.42	9.32	2319.06	6525.88	2239.10	2239.10	8764.98	6168.73	2596.25	1.42
Bypass - Existing Dam	3404.44	30.56	2225.90	38.25	5699.15	3145.79	2239.10	0.00	3145.79	6070.04	-2924.25	0.52
Bypass - SkDam 1	2996.60	98.17	542.00	9.28	3646.05	5198.89	2239.10	0.00	5198.89	6882.46	-1683.57	0.76
Bypass - SkDam 2	2977.01	94.28	458.70	6.60	3536.59	5308.35	2239.10	0.00	5308.35	7526.87	-2218.52	0.71
Alternative 7 - Existing Dam	3382.07	97.10	2288.89	41.94	5810.00	3034.94	2239.10	0.00	3034.94	5081.55	-2046.61	0.60
Alternative 7 - SkDam 1	2899.76	74.89	601.44	18.63	3594.72	5250.22	2239.10	0.00	5250.22	5718.95	-468.73	0.92
Alternative 7 - SkDam 2	2869.41	70.80	526.26	7.69	3474.16	5370.78	2239.10	0.00	5370.78	5869.87	-499.09	0.91

[1]I-5 avoided cost savings and traffic delay reductions

8.4.2 Skookumchuck Dam Modification

The Skookumchuck Dam was included in the evaluation as a first added element to determine the flood reduction effectiveness. There were two storage alternatives evaluated: an 11,000 acre-foot dam and a 20,000 acre-foot dam. Each storage component was evaluated for each of the Chehalis plans. The incremental benefit for the CheLev2 plan with the 11,000 dam is $2,107 with an incremental B/C of 1.94. The combined plan yields net benefit of $2,698.64 with a B/C of 1.48. This includes the impacts of the dam on the Chehalis since the effects are captured in the resultant hydraulic analysis. The incremental benefit for raising the CheLev2 plan from 11,000 to the 20,000 dam is $122 with an incremental cost of $217, an incremental B/C of 0.56. Increasing the dam size from 11,000 to 20,000 is not justified and for this reason the analysis assumes that the 11,000 dam is incrementally justified as the first added element.

8.4.3 Skookumchuck Levee

In an attempt to further reduce flooding on the Skookumchuck River, specifically in Reach 4, levees along the Skookumchuck River were analyzed. The incremental net benefit change from CheLev2 plan with the 11,000 dam to the CheLev2 plan with the 11,000 dam and Skookumchuck levees is -$6; and, given that the ChevLev2 with 11,000 dam alternative does not consider backwater effects on the Skookumchuck River at this stage, it is reasonable to assume that the CheLev2–SKDam and SKLev plan type would most likely generate the NED recommended plan.

8.5 PHASE 2 - SCREENING RESULTS, PRELIMINARY NED ALTERNATIVE

Based on economic performance and engineering performance evaluated in screening Phase 2, the most effective alternative for reducing flood damages was identified as a combination of the flood control features Chehalis Levee, Skookumchuck Dam, and Skookumchuck Levee. This alternative appears to produce the highest net benefits. The NED size of each measure and as a combined system will be determined in the next iteration of optimization, Phase 3. At this time, no plan satisfies FEMA's Conditional Non-Exceedance Probability criteria for both rivers. However, the Chehalis Levee 2 Plan alternative meets the 0.01 Conditional Non-Exceedance Probability for the Chehalis River along the protected areas. To achieve the same performance along the Skookumchuck River, it appears that additional levees will need to be included along with a dam measure. The optimization exercise to be performed in Phase 3 may yield a smaller Skookumchuck Levee that performs better than the one tested in Phase 2.

9. Phase 3 – Optimization and Identification of NED Plan

In the final phase of plan formulation, several different sizes of the preliminary NED plan were further evaluated for optimization of project size. This optimization resulted in identification of the NED plan.

The previous section identified and examined potential solution modes to flood-related problems in the study area. This examination indicated that a potential solution involving dam modification and levee improvements might be justified. In this phase, the analysis' focus is on this potential dam/levee solution mode. As with the previous analyses outlined in this report, the analysis of dam/levee alternatives employs the HEC-FDA model. The with-project HEC-FDA conditions for each alternative were modeled by modifying the existing hydraulic condition input data according to the results of the UNET modeling to derive residual damages and project performance measures. For example, if a particular discharge-frequency or stage-discharge function was altered as a result of a particular measure (levee, bypass, or reservoir), the appropriate without-project data set was modified and HEC-FDA recalculated residual damages and performance parameters. The array of alternatives analyzed in this phase consists of three basic features, as follows:

- Skookumchuck Dam Modification;
- Chehalis River Levee Improvements; and
- Skookumchuck River Levee Improvements.

Each of these basic features has an array of its own. For Skookumchuck Dam, two storage capacity level increases are under consideration with these capacity increases being,

- an 11,000 acre-foot increase
- a 20,000 acre-foot increase.

For the Chehalis and Skookumchuck rivers' five levee improvement levels are considered for each with these levels being,

- a levee height 2 feet below the 100-yr WSE[4];
- a levee height at the 100-yr WSE;
- a levee height that has a 75-yr level of flood protection;
- a levee height that has a 100-yr level of flood protection;
- a levee height of approximately 200-yr level of protection; and
- a backwater levee only option on the Skookumchuck River.

These basic modes in combination comprise 54 potential alternatives, as shown in Table 41, below.

[4] As the study is conducted under a risk-based approach, the "100-year" flood consists of a distribution of floods defined by risk-based parameters as presented in hydraulics and hydrology appendices. For the 100-year WSE, the mean values of the risk parameters associated with the 1 percent chance flood were utilized to develop the water surface elevation. To provide protection of a given frequency, and as a flood of a given frequency consists of many differing levels, the height of the levee must contain 95 percent of that level's distribution of floods.

TABLE 41: PHASE III PRELIMINARY ALTERNATIVES

Skookumchuck	Chehalis Levee	Skookumchuck Levee
Existing	100	Backwater
11,000	100	Backwater
11,000	WSE -1	WSE -1
11,000	WSE -1	WSE
11,000	WSE -1	200
11,000	WSE -1	100
11,000	WSE -1	75
11,000	WSE	WSE -1
11,000	WSE	WSE
11,000	WSE	200
11,000	WSE	100
11,000	WSE	75
11,000	75	WSE -1
11,000	75	WSE
11,000	75	200
11,000	75	100
11,000	75	75
11,000	100	WSE-3
11,000	100	WSE-2
11,000	100	WSE -1
11,000	100	WSE
11,000	100	200
11,000	100	100
11,000	100	75
11,000	200	WSE -1
11,000	200	WSE
11,000	200	200
11,000	200	100
11,000	200	75
20,000	WSE -1	WSE -1
20,000	WSE -1	WSE
20,000	WSE -1	200
20,000	WSE -1	100
20,000	WSE -1	75
20,000	WSE	WSE -1
20,000	WSE	WSE
20,000	WSE	200
20,000	WSE	100
20,000	WSE	75
20,000	75	WSE -1
20,000	75	WSE
20,000	75	200
20,000	75	100
20,000	75	75
20,000	100	WSE -1
20,000	100	WSE
20,000	100	200
20,000	100	100
20,000	100	75
20,000	200	WSE -1

Skookumchuck	Chehalis Levee	Skookumchuck Levee
20,000	200	WSE
20,000	200	200
20,000	200	100
20,000	200	75

The HEC-FDA model was employed to determine residual damages for all damages except for those damages related to agriculture and transportation. In the case of agricultural damages, the designs of the alternatives would not afford protection to the Chehalis River's west side in the area of agricultural production, and agricultural damage reductions would be minimal, if at all. Therefore, no agricultural damage reductions are claimed for any alternative. In the case of rail freight transportation damages, the proposed alternatives would not fully cover the potentially impacted rail lines and transportation delays would continue during flooding events; therefore, no damage reductions are claimed.

In the without-project condition, traffic on I-5 experiences delays during flood events. I-5 is scheduled to have major modifications made by 2012 to increase its capacity and to eliminate flood-related delays. The related cost to elevate I-5 to avoid flood delays is $44,000,000. The without-project analysis indicates that the annual damages associated with traffic delays on I-5 are $476,300. Full implementation of flood control operations for all alternatives is 2007. Applying a net present value approach to the expected annual traffic delay costs during the 2007 to 2012 timeframe yields an annual damage reduction (benefit) of $129,079, if implemented.

Currently there are plans to upgrade and modernize I-5 to increase its capacity and remove it from the threat of flooding. The current cost of this future modernization for elevating the roadway above the 100-year event is estimated at $44,000,000. The plan for I-5 indicates that implementation would take place after the base year of any of the alternatives and would be finished in 2012. If an alternative with at least a 100-year level of protection is implemented, modernization of I-5 would avoid the elevation expenditure of $44,000,000. As this expenditure would occur in the future after the construction of an alternative, discounting this future cost yields a current base year value of $32,686,200. Amortization of this avoided expenditure yields an annual savings of $2,110,000.

NED benefits for the alternatives are shown in Table 42, below.

TABLE 42: PHASE III ALTERNATIVES NED BENEFITS

(in $1,000s, 2002 price level, 6.125% discount rate, 50-year period of analysis)

Skookumchuck Dam	Chehalis Levee	Skookumchuck Levee	Residual Damages*	Damage Reduction	I-5 Avoided Costs	I-5 Delay Benefits	Total Benefits
No Action	100	Backwater	4577.55	4267.37	2110.00	129.10	6,506.47
11,000	100	Backwater	2647.88	6197.04	2110.00	129.10	8,436.14
11,000	WSE -1	WSE -1	4340.59	4504.33	0.00	0.00	4504.33
11,000	WSE -1	WSE	4320.37	4524.55	0.00	0.00	4524.55
11,000	WSE -1	75	4305.28	4539.64	0.00	0.00	4539.64
11,000	WSE -1	100	4256.03	4588.89	0.00	0.00	4588.89
11,000	WSE -1	200	4213.24	4631.68	0.00	0.00	4631.68
20,000	WSE -1	WSE -1	4179.64	4665.28	0.00	0.00	4665.28
20,000	WSE -1	WSE	4157.31	4687.61	0.00	0.00	4687.61
20,000	WSE -1	75	4142.48	4702.44	0.00	0.00	4702.44
20,000	WSE -1	100	4087.72	4757.2	0.00	0.00	4757.20
20,000	WSE -1	200	4060.17	4784.75	0.00	0.00	4784.75
11,000	WSE	WSE -1	3695.48	5149.44	0.00	0.00	5149.44
11,000	WSE	WSE	3675.26	5169.66	0.00	0.00	5169.66
11,000	WSE	75	3660.17	5184.75	0.00	0.00	5184.75
11,000	WSE	100	3610.93	5233.99	0.00	0.00	5233.99
11,000	WSE	200	3568.13	5276.79	0.00	0.00	5276.79
20,000	WSE	WSE -1	3540.11	5304.81	0.00	0.00	5304.81
20,000	WSE	WSE	3517.77	5327.15	0.00	0.00	5327.15
20,000	WSE	75	3502.94	5341.98	0.00	0.00	5341.98
20,000	WSE	100	3448.18	5396.74	0.00	0.00	5396.74
20,000	WSE	200	3420.63	5424.29	0.00	0.00	5424.29
11,000	75	WSE -1	2983.3	5861.62	0.00	0.00	5861.62
11,000	75	WSE	2963.1	5881.82	0.00	0.00	5881.82
11,000	75	75	2948	5896.92	0.00	0.00	5896.92
11,000	75	100	2898.76	5946.16	0.00	0.00	5946.16
11,000	75	200	2855.97	5988.95	0.00	0.00	5988.95
20,000	75	WSE -1	2846.42	5998.5	0.00	0.00	5998.50
20,000	75	WSE	2824.1	6020.82	0.00	0.00	6020.82
20,000	75	75	2809.27	6035.65	0.00	0.00	6035.65
20,000	75	100	2754.5	6090.42	0.00	0.00	6090.42
20,000	75	200	2726.94	6117.98	0.00	0.00	6117.98
11,000	100	WSE-3	2591.48	6253.44	2110.00	129.10	8492.54
11,000	100	WSE-2	2556.29	6288.63	2110.00	129.10	8527.73
11,000	100	WSE -1	2533.37	6311.55	2110.00	129.10	8,550.65
11,000	100	WSE	2513.16	6331.76	2110.00	129.10	8,570.86
11,000	100	75	2498.06	6346.86	2110.00	129.10	8,585.96
11,000	100	100	2448.83	6396.09	2110.00	129.10	8,635.19
20,000	100	WSE -1	2409.98	6434.94	2110.00	129.10	8,674.04
11,000	100	200	2406.04	6438.88	2110.00	129.10	8,677.98
20,000	100	WSE	2388.65	6456.27	2110.00	129.10	8,695.37
20,000	100	75	2373.82	6471.1	2110.00	129.10	8,710.20
11,000	200	WSE -1	2337.05	6507.87	2110.00	129.10	8,746.97
20,000	100	100	2319.05	6525.87	2110.00	129.10	8,764.97
11,000	200	WSE	2316.83	6528.09	2110.00	129.10	8,767.19
11,000	200	75	2301.74	6543.18	2110.00	129.10	8,782.28
20,000	100	200	2291.5	6553.42	2110.00	129.10	8,792.52
11,000	200	100	2252.5	6592.42	2110.00	129.10	8,831.52
20,000	200	WSE -1	2223	6621.92	2110.00	129.10	8,861.02
11,000	200	200	2209.71	6635.21	2110.00	129.10	8,874.31
20,000	200	WSE	2200.67	6644.25	2110.00	129.10	8,883.35
20,000	200	75	2185.85	6659.07	2110.00	129.10	8,898.17
20,000	200	100	2131.07	6713.85	2110.00	129.10	8,952.95
20,000	200	200	2103.52	6741.4	2110.00	129.10	8,980.50

***Residual damages in this table do not include agriculture damages and rail damages – both these categories are not affected by proposed alternatives. Residual annual damages in these categories are $115,850 for agriculture and $32,200 for rail.*

Construction and annual costs for the various components are shown below in Table 43.

TABLE 43: COMPONENT COSTS

ALTERNATIVE	Total Construction Cost*	IDC	Total Economic Cost	Annualized Cost	O&M	TOTAL ANNUAL COST
Skookumchuck Dam						
Skookumchuck Dam 11,000 ac-ft	$9,304.05	$569.87	$9,873.93	$637.40	$448.30	$1,085.70
Skookumchuck Dam 20,000 ac-ft	$11,507.02	$704.80	$12,211.82	$788.32	$514.51	$1,302.83
Skookumchuck Levee						
Backwater	$8,122.00	$497.47	$8,619.47	$556.00	$19.03	$575.03
100yr WSE -3	$9,006.00	$551.62	$9,557.62	$617.00	$19.03	$636.03
100yr WSE -2	$9,602.00	$588.12	$10,190.12	$623.00	$19.03	642.03
100yr WSE -1	$9,774.00	$598.66	$10,372.66	$669.00	$19.03	$688.03
100yr WSE	$10,410.00	$637.61	$11,047.61	$713.00	$19.03	$732.03
75yr Protection	$10,952.00	$670.81	$11,622.81	$750.30	$19.03	$769.32
100yr Protection	$13,162.00	$806.17	$13,968.17	$901.70	$19.03	$920.73
200yr Protection	$14,482.00	$887.02	$15,369.02	$992.13	$19.03	$1,011.16
Chehalis Levee						
100yr WSE -1	$48,155.46	$2,949.52	$51,104.98	$3,299.03	$99.49	$3,398.52
100yr WSE	$50,705.46	$3,105.71	$53,811.17	$3,473.73	$99.49	$3,573.22
75yr Protection	$53,675.46	$3,287.62	$56,963.08	$3,677.19	$99.49	$3,776.69
100yr Protection	$60,905.46	$3,730.46	$64,635.92	$4,172.51	$99.49	$4,272.00
200yr Protection	$64,975.46	$3,979.75	$68,955.21	$4,451.33	$99.49	$4,550.83

**includes Real Estate*
***interest during construction is calculated using a two-year midlife full expenditure pattern with a 6.125% discount rate.*

These components in combination form the alternatives and have total costs and net benefits as shown in Table 44, below.

TABLE 44: TOTAL ANNUAL COSTS AND NED NET BENEFITS PHASE II ALTERNATIVES

(in $1,000s, 2002 price level, 6.125% discount rate, 50-year period of analysis)

Dam Size	Chehalis Levee*	Skookumchuck Levee*	Residual Damages**	Damage Reduction	I-5 Avoided Costs	I-5 Delay Benefits	Total Benefits	Skook Dam Cost	Chehalis Levee Cost	Skook Levee Cost	Total Cost	Net Benefits
11	100	-2	$2,556.28	$6,288.65	$2,110.00	$129.10	$8,527.75	$1,085.70	$4,272.00	$642.03	$5,999.73	$2,528.00
11	100	-1	$2,533.37	$6,311.55	$2,110.00	$129.10	$8,550.65	$1,085.70	$4,272.00	$688.03	$6,045.73	$2,504.92
11	100	BW	$2,647.88	$6,197.04	$2,110.00	$129.10	$8,436.14	$1,085.70	$4,272.00	$575.03	$5,932.73	$2,503.41
11	100	-3	$2,591.48	$6,253.44	$2,110.00	$129.10	$8,492.54	$1,085.70	$4,272.00	$636.03	$5,993.73	$2,498.81
11	100	0	$2,513.16	$6,331.76	$2,110.00	$129.10	$8,570.86	$1,085.70	$4,272.00	$732.03	$6,089.73	$2,481.13
11	100	75	$2,498.06	$6,346.86	$2,110.00	$129.10	$8,585.96	$1,085.70	$4,272.00	$769.32	$6,127.02	$2,458.94
11	200	-1	$2,337.05	$6,507.87	$2,110.00	$129.10	$8,746.97	$1,085.70	$4,550.83	$663.14	$6,299.66	$2,447.31
20	100	-1	$2,409.98	$6,434.94	$2,110.00	$129.10	$8,674.04	$1,302.83	$4,272.00	$663.14	$6,237.97	$2,436.07
11	200	0	$2,316.83	$6,528.09	$2,110.00	$129.10	$8,767.19	$1,085.70	$4,550.83	$711.09	$6,347.62	$2,419.57
20	100	0	$2,388.65	$6,456.27	$2,110.00	$129.10	$8,695.37	$1,302.83	$4,272.00	$711.09	$6,285.92	$2,409.45
11	200	75	$2,301.74	$6,543.18	$2,110.00	$129.10	$8,782.28	$1,085.70	$4,550.83	$769.32	$6,405.85	$2,376.43
20	100	75	$2,373.82	$6,471.10	$2,110.00	$129.10	$8,710.20	$1,302.83	$4,272.00	$769.32	$6,344.16	$2,366.04
11	100	100	$2,448.83	$6,396.09	$2,110.00	$129.10	$8,635.19	$1,085.70	$4,272.00	$920.73	$6,278.42	$2,356.77
20	200	-1	$2,223.00	$6,621.92	$2,110.00	$129.10	$8,861.02	$1,302.83	$4,550.83	$663.14	$6,516.80	$2,344.22
20	200	0	$2,200.67	$6,644.25	$2,110.00	$129.10	$8,883.35	$1,302.83	$4,550.83	$711.09	$6,564.75	$2,318.60
11	100	200	$2,406.04	$6,438.88	$2,110.00	$129.10	$8,677.98	$1,085.70	$4,272.00	$1,011.16	$6,368.85	$2,309.13
20	200	75	$2,185.85	$6,659.07	$2,110.00	$129.10	$8,898.17	$1,302.83	$4,550.83	$769.32	$6,622.98	$2,275.19
11	200	100	$2,252.50	$6,592.42	$2,110.00	$129.10	$8,831.52	$1,085.70	$4,550.83	$920.73	$6,557.25	$2,274.27
20	100	100	$2,319.05	$6,525.87	$2,110.00	$129.10	$8,764.97	$1,302.83	$4,272.00	$920.73	$6,495.56	$2,269.41
11	200	200	$2,209.71	$6,635.21	$2,110.00	$129.10	$8,874.31	$1,085.70	$4,550.83	$1,011.16	$6,647.68	$2,226.63
20	100	200	$2,291.50	$6,553.42	$2,110.00	$129.10	$8,792.52	$1,302.83	$4,272.00	$1,011.16	$6,585.99	$2,206.53
20	200	100	$2,131.07	$6,713.85	$2,110.00	$129.10	$8,952.95	$1,302.83	$4,550.83	$920.73	$6,774.38	$2,178.57
20	200	200	$2,103.52	$6,741.40	$2,110.00	$129.10	$8,980.50	$1,302.83	$4,550.83	$1,011.16	$6,864.82	$2,115.68
Ext	100	BW	$4,577.55	$4,267.37	$2,110.00	$129.10	$6,506.47	$0.00	$4,272.00	$591.89	$4,863.89	$1,642.58
11	75	-1	$2,983.30	$5,861.62	$0.00	$0.00	$5,861.62	$1,085.70	$3,776.69	$663.14	$5,525.52	$336.10
11	75	0	$2,963.10	$5,881.82	$0.00	$0.00	$5,881.82	$1,085.70	$3,776.69	$711.09	$5,573.48	$308.34
11	75	75	$2,948.00	$5,896.92	$0.00	$0.00	$5,896.92	$1,085.70	$3,776.69	$769.32	$5,631.71	$265.21
20	75	-1	$2,846.42	$5,998.50	$0.00	$0.00	$5,998.50	$1,302.83	$3,776.69	$663.14	$5,742.66	$255.84
20	75	0	$2,824.10	$6,020.82	$0.00	$0.00	$6,020.82	$1,302.83	$3,776.69	$711.09	$5,790.61	$230.21

Dam Size	Chehalis Levee*	Skookumchuck Levee*	Residual Damages**	Damage Reduction	I-5 Avoided Costs	I-5 Delay Benefits	Total Benefits	Skook Dam Cost	Chehalis Levee Cost	Skook Levee Cost	Total Cost	Net Benefits
20	75	75	$2,809.27	$6,035.65	$0.00	$0.00	$6,035.65	$1,302.83	$3,776.69	$769.32	$5,848.84	$186.81
11	75	100	$2,898.76	$5,946.16	$0.00	$0.00	$5,946.16	$1,085.70	$3,776.69	$920.73	$5,783.11	$163.05
11	75	200	$2,855.97	$5,988.95	$0.00	$0.00	$5,988.95	$1,085.70	$3,776.69	$1,011.16	$5,873.54	$115.41
20	75	100	$2,754.50	$6,090.42	$0.00	$0.00	$6,090.42	$1,302.83	$3,776.69	$920.73	$6,000.25	$90.17
20	75	200	$2,726.94	$6,117.98	$0.00	$0.00	$6,117.98	$1,302.83	$3,776.69	$1,011.16	$6,090.68	$27.30
11	0	-1	$3,695.48	$5,149.44	$0.00	$0.00	$5,149.44	$1,085.70	$3,573.22	$663.14	$5,322.05	-$172.61
11	0	0	$3,675.26	$5,169.66	$0.00	$0.00	$5,169.66	$1,085.70	$3,573.22	$711.09	$5,370.01	-$200.35
20	0	-1	$3,540.11	$5,304.81	$0.00	$0.00	$5,304.81	$1,302.83	$3,573.22	$663.14	$5,539.19	-$234.38
11	0	75	$3,660.17	$5,184.75	$0.00	$0.00	$5,184.75	$1,085.70	$3,573.22	$769.32	$5,428.24	-$243.49
20	0	0	$3,517.77	$5,327.15	$0.00	$0.00	$5,327.15	$1,302.83	$3,573.22	$711.09	$5,587.14	-$259.99
20	0	75	$3,502.94	$5,341.98	$0.00	$0.00	$5,341.98	$1,302.83	$3,573.22	$769.32	$5,645.37	-$303.39
11	0	100	$3,610.93	$5,233.99	$0.00	$0.00	$5,233.99	$1,085.70	$3,573.22	$920.73	$5,579.64	-$345.65
11	0	200	$3,568.13	$5,276.79	$0.00	$0.00	$5,276.79	$1,085.70	$3,573.22	$1,011.16	$5,670.07	-$393.28
20	0	100	$3,448.18	$5,396.74	$0.00	$0.00	$5,396.74	$1,302.83	$3,573.22	$920.73	$5,796.78	-$400.04
20	0	200	$3,420.63	$5,424.29	$0.00	$0.00	$5,424.29	$1,302.83	$3,573.22	$1,011.16	$5,887.21	-$462.92
11	-1	-1	$4,340.59	$4,504.33	$0.00	$0.00	$4,504.33	$1,085.70	$3,398.52	$663.14	$5,147.36	-$643.03
11	-1	0	$4,320.37	$4,524.55	$0.00	$0.00	$4,524.55	$1,085.70	$3,398.52	$711.09	$5,195.31	-$670.76
20	-1	-1	$4,179.64	$4,665.28	$0.00	$0.00	$4,665.28	$1,302.83	$3,398.52	$663.14	$5,364.49	-$699.21
11	-1	75	$4,305.28	$4,539.64	$0.00	$0.00	$4,539.64	$1,085.70	$3,398.52	$769.32	$5,253.54	-$713.90
20	-1	0	$4,157.31	$4,687.61	$0.00	$0.00	$4,687.61	$1,302.83	$3,398.52	$711.09	$5,412.45	-$724.84
20	-1	75	$4,142.48	$4,702.44	$0.00	$0.00	$4,702.44	$1,302.83	$3,398.52	$769.32	$5,470.68	-$768.24
11	-1	100	$4,256.03	$4,588.89	$0.00	$0.00	$4,588.89	$1,085.70	$3,398.52	$920.73	$5,404.95	-$816.06
11	-1	200	$4,213.24	$4,631.68	$0.00	$0.00	$4,631.68	$1,085.70	$3,398.52	$1,011.16	$5,495.38	-$863.70
20	-1	100	$4,087.72	$4,757.20	$0.00	$0.00	$4,757.20	$1,302.83	$3,398.52	$920.73	$5,622.08	-$864.88
20	-1	200	$4,060.17	$4,784.75	$0.00	$0.00	$4,784.75	$1,302.83	$3,398.52	$1,011.16	$5,712.51	-$927.76

Table 44 provides the results of the maximization analysis that was used to determine that project scope, or investment, where the last increment of cost is equal to the incremental benefit. Based on the above analyses, the three-element plan that most reasonably maximizes net NED benefits, the NED Plan, consists of the following.

- an 11,000 acre-foot modification plan for the Skookumchuck Dam;
- levee construction of 100-year level protection on the Chehalis; and
- construction of a levee at 2-feet below the 100-year WSE on the Skookumchuck River.

Residual damages for the NED Plan are shown in Table 45, below.

TABLE 45: NED PLAN RESIDUAL DAMAGES

Expected Annual Flood Damage for the NED Plan*
11,000 ac/ft Skookumchuck Dam modification, 100-yr Protection Levee Chehalis River, & 100-yr WSE -2 Skookumchuck Levee
(Damage in $1,000's, 6.125%, 50 -year analysis period)

Alternative	Damage Categories											
	Com - Cleanup	Com -Cnt	Com - Str	PA	Res - Cleanup	Res - Cnt	Res - Str	TRA	Pub - Cleanup	Pub – Cnt	Pub – Str	Total
Without-project Damages	301.36	1431.16	1354.95	405.13	866.89	1430.52	2453.00	116.63	28.76	204.65	251.88	8844.92
NED Plan	27.45	201.48	175..75	160.46	314.51	573.63	993.52	46.29	5.08	24.50	33.61	2556.28
Damage Reduction	**273.91**	**1229.68**	**1179.20**	**244.67**	**552.38**	**856.89**	**1459.48**	**70.34**	**23.68**	**180.15**	**218.27**	**6288.65**

**Damages in this table do not include agriculture damages and rail damages – both these categories are not affected by recommended project. Residual annual damages in these categories are $115,850 for agriculture and $32,200 for rail. Additional project benefits categories of NED plan include $2,110,000 in avoided cost of fill for elevating I-5 and $129,100 in reduced traffic delays. Incorporating these values results in the following:*
*Without-project damages including agricultural damages, rail damages, and traffic delays and cost of elevating I-5: **$11,232.06***
*NED Plan residual damages including agricultural damages and rail damages: **$2,681.42***
*NED Plan damage reduction including avoided cost of fill for elevating I-5 and reduced traffic delays: $**8,527.75***

APPENDIX A – HEC-FDA MODEL DATA

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		Reach		Chehalis 1
		Index Cross-Section (RM)		74.02
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
N/A	N/A	451	150.00	0.00
2	0.500	21,637	173.68	0.49
5	0.200	29,146	175.54	0.52
10	0.100	33,592	176.37	0.51
25	0.040	43,313	177.79	0.47
50	0.020	50,891	178.58	0.42
100	0.010	56,851	179.16	0.40
200	0.005	66,681	179.92	0.40
500	0.002	79,143	180.96	0.56
N/A	N/A	100,000	**183.00**	0.56

		Reach		Chehalis 2
		Index Cross-Section (RM)		72.80
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
N/A	N/A	451	149.95	0.00
2	0.500	20,231	172.34	0.57
5	0.200	28,237	174.47	0.54
10	0.100	32,582	175.32	0.51
25	0.040	42,186	176.77	0.47
50	0.020	48,736	177.53	0.50
100	0.010	52,747	178.12	0.54
200	0.005	60,574	178.89	0.73
500	0.002	67,166	180.06	1.02
N/A	N/A	90,000	**182.50**	1.02

		Reach		Chehalis 3
		Index Cross-Section (RM)		70.30
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
N/A	N/A	451	149.90	0.00
2	0.500	18,648	168.22	0.59
5	0.200	27,623	170.45	0.58
10	0.100	32,011	171.62	0.67
25	0.040	41,029	173.58	0.93
50	0.020	46,116	174.81	1.07
100	0.010	49,638	175.86	1.14
200	0.005	54,031	177.05	1.18
500	0.002	60,445	178.58	1.10
N/A	N/A	80,000	**182.00**	1.10

		Reach		Chehalis 4
		Index Cross-Section (RM)		68.67
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
N/A	N/A	451	149.90	0.00
2	0.500	18,743	166.90	0.75
5	0.200	27,075	169.82	0.75
10	0.100	31,511	171.14	0.76

		Reach		Chehalis 4
		Index Cross-Section (RM)		68.67
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
25	0.040	40,364	173.22	0.78
50	0.020	47,113	174.50	0.81
100	0.010	52,678	175.59	0.84
200	0.005	59,865	176.81	0.87
500	0.002	69,541	178.36	0.90
N/A	N/A	90,000	**181.50**	0.90

		Reach		Chehalis 5
		Index Cross-Section (RM)		67.29
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
N/A	N/A	471	149.90	0.00
2	0.500	18,718	165.45	0.78
5	0.200	27,071	168.36	0.72
10	0.100	31,396	169.59	0.70
25	0.040	40,512	171.42	0.68
50	0.020	47,289	172.47	0.68
100	0.010	53,343	173.40	0.69
200	0.005	61,636	174.40	0.74
500	0.002	72,201	175.72	0.86
N/A	N/A	95,000	**178.50**	0.86

		Reach		Chehalis 6
		Index Cross-Section (RM)		66.30
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
N/A	N/A	599	149.80	0.00
2	0.500	24,251	161.89	0.60
5	0.200	34,728	164.10	0.68
10	0.100	41,029	165.28	0.71
25	0.040	52,740	167.03	0.72
50	0.020	61,363	167.96	0.71
100	0.010	70,006	168.81	0.70
200	0.005	80,817	169.81	0.70
500	0.002	96,788	171.06	0.77
N/A	N/A	120,000	**173.00**	0.77

		Reach		Chehalis 7
		Index Cross-Section (RM)		65.20
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
N/A	N/A	323	143.75	0.00
2	0.500	24,260	157.97	0.66
5	0.200	34,717	160.67	0.63
10	0.100	41,006	162.01	0.61
25	0.040	52,754	163.70	0.59
50	0.020	61,399	164.67	0.57
100	0.010	70,026	165.51	0.56
200	0.005	80,800	166.50	0.55
500	0.002	96,802	167.77	0.55
N/A	N/A	120,000	**169.50**	0.55

		Reach		Skookumchuck 1
		Index Cross-Section (RM)		10.56
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
N/A	N/A	1,263	234.59	0.39
3.1	0.323	4,129	238.59	0.39
6.1	0.164	5,750	239.82	0.40
12.7	0.079	7,147	240.68	0.40
34	0.029	9,238	241.74	0.41
50	0.020	10,258	242.17	0.42
88	0.011	11,428	242.60	0.43
143	0.007	12,500	242.97	0.44
320	0.0031	14,331	243.60	0.46
482	0.0021	15,750	244.04	0.49
N/A	N/A	25,000	**247.00**	0.49

		Reach		Skookumchuck 2
		Index Cross-Section (RM)		5.08
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
N/A	N/A	1,319	195.60	0.39
3.1	0.323	4,191	200.89	0.39
6.1	0.164	5,797	202.01	0.36
12.7	0.079	7,355	202.89	0.33
34	0.029	9,393	203.62	0.27
50	0.020	10,561	203.92	0.24
88	0.011	11,804	204.19	0.21
143	0.007	12,940	204.43	0.20
320	0.0031	14,867	204.81	0.20
482	0.0021	16,137	205.04	0.23
N/A	N/A	25,000	**206.70**	0.23

		Reach		Skookumchuck 3
		Index Cross-Section (RM)		2.415
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
N/A	N/A	2,039	180.55	0.40
3.1	0.323	5,369	184.00	0.40
6.1	0.164	7,423	185.19	0.37
12.7	0.079	9,322	185.89	0.35
34	0.029	12,147	186.65	0.32
50	0.020	13,792	187.06	0.30
88	0.011	16,183	187.56	0.28
143	0.007	17,885	187.79	0.26
320	0.0031	21,158	188.07	0.24
N/A	N/A	40,000	**189.50**	0.24

		Reach		Skookumchuck 4
		Index Cross-Section (RM)		0.98
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
N/A	N/A	2,141	165.82	0.68
3.1	0.323	5,508	171.31	0.68
6.1	0.164	7,623	173.77	0.48

		Reach		Skookumchuck 4
		Index Cross-Section (RM)		0.98
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
12.7	0.079	9,553	174.36	0.37
34	0.029	12,381	175.21	0.32
50	0.020	14,091	175.84	0.33
88	0.011	16,554	176.39	0.39
143	0.007	18,124	176.90	0.44
320	0.0031	21,195	177.69	0.56
N/A	N/A	40,000	**181.00**	0.56

Chehalis River

Reach Number	Extent of reach in terms of river miles (RM)	Index Cross-Section for Reach (RM) [1]	Description
Chehalis 1	RM 75.2 to RM 73	RM 74.02	Confluence of Chehalis/Newaukum rivers to south end of airport
Chehalis 2	RM 73 to RM 71.5	RM 72.80	South end of airport to north end of airport
Chehalis 3	RM 71.5 to RM 69.2	RM 70.30	North end of airport to confluence of Chehalis River/Salzer Creek
Chehalis 4	RM 69.2 to RM 67.45	RM 68.67	Confluence of Chehalis River/Salzer Creek to Mellen St. Bridge
Chehalis 5	RM 67.45 to RM 66.9	RM 67.29	Mellen St. Bridge to confluence of Chehalis/Skookumchuck rivers
Chehalis 6	RM 66.9 to RM 66.0	RM 66.30	Confluence of Chehalis/Skookumchuck rivers to downstream end of proposed floodway excavation
Chehalis 7	RM 66.0 to RM 61.8	RM 65.20	Downstream end of proposed floodway excavation to Chehalis/Lincoln Creek confluence

1 - Index cross-sections for Chehalis River reaches are referenced to Skookumchuck River river mile (RM)

Skookumchuck River

Reach Number	Description of reach	Index Cross-Section for Reach (RM) [2]	Description
Skookumchuck 1	Town of Bucoda	RM 10.56	Town of Bucoda
Skookumchuck 2	RM 5.08 to RM 3.85	RM 5.08	Skookumchuck river mile 5.08 to confluence of Skookumchuck River/Hanaford Creek
Skookumchuck 3	RM 3.84 to RM 1.57	RM 2.415	Confluence of Skookumchuck River/Hanaford Creek to confluence of Skookumchuck River/Coffee Creek
Skookumchuck 4	RM 1.57 to RM 0.22	RM 0.98	Confluence of Skookumchuck River/Coffee Creek to limit of backwater effect from Chehalis River on Skookumchuck River

2 - Index cross-sections for Skookumchuck River reaches are referenced to Skookumchuck River river mile (RM)

UNET storage areas in the Chehalis/Centralia area and links to index cross-sections for the HEC-FDA analysis			
Storage Area Number [1]	River cross-section that storage area is hydraulically linked to [2]	Associated Economics Reach [3]	Associated Index Cross-Section [3]
102	Newaukum RM 0.08	Chehalis Econ. Reach 1	Chehalis RM 74.02
101	Newaukum RM 0.08	Chehalis Econ. Reach 1	Chehalis RM 74.02
100	Chehalis RM 76.70	Chehalis Econ. Reach 1	Chehalis RM 74.02
301	Dillenbaugh RM 0.623	Chehalis Econ. Reach 1	Chehalis RM 74.02
302	Dillenbaugh RM 0.623	Chehalis Econ. Reach 1	Chehalis RM 74.02
303	Chehalis RM 74.57	Chehalis Econ. Reach 1	Chehalis RM 74.02
2	Chehalis RM 72.80	Chehalis Econ. Reach 2	Chehalis RM 72.80
3	Salzer RM 1.56	Chehalis Econ. Reach 4	Chehalis RM 68.67
4	Salzer RM 1.28	Chehalis Econ. Reach 4	Chehalis RM 68.67
5	Chehalis RM 68.05	Chehalis Econ. Reach 4	Chehalis RM 68.67
501	Chehalis RM 68.67	Chehalis Econ. Reach 4	Chehalis RM 68.67
601	Skookumchuck RM 2.99	Skookumchuck Econ. Reach 3	Skookumchuck RM 2.415
602	Skookumchuck RM 2.415	Skookumchuck Econ. Reach 3	Skookumchuck RM 2.415
603	China Creek - N/A [4]	Not included in stage-damage function	N/A
604	China Creek - N/A [4]	Not included in stage-damage function	N/A
605	China Creek - N/A [4]	Not included in stage-damage function	N/A
606	Skookumchuck RM 2.00	Skookumchuck Econ. Reach 3	Skookumchuck RM 2.415
608	China Creek - N/A [4]	Not included in stage-damage function	N/A
609	Skookumchuck RM 0.49	Skookumchuck Econ. Reach 4	Skookumchuck RM 0.98
610	Chehalis RM 67.36	Chehalis Econ. Reach 5	Chehalis RM 67.29
701	Skookumchuck RM 5.08	Skookumchuck Econ. Reach 2	Skookumchuck RM 5.08
702	Skookumchuck RM 5.08	Skookumchuck Econ. Reach 2	Skookumchuck RM 5.08
703	Skookumchuck RM 5.08	Skookumchuck Econ. Reach 2	Skookumchuck RM 5.08
704	Skookumchuck RM 5.08	Skookumchuck Econ. Reach 2	Skookumchuck RM 5.08
705	Skookumchuck RM 2.00	Skookumchuck Econ. Reach 3	Skookumchuck RM 2.415

1 - Storage Area number as related to the Chehalis UNET model and as delineated on the 1"=400' scale maps.
2 - Stream and river mile most closely associated with overflow to storage area.
3 - Economics reach and associated index cross-section that should be used to link the storage area to hydrologic (discharge-probability) and hydraulic (stage-discharge) information.
4 - Storage area is mostly flooded from China Creek (China Creek is not modeled hydraulically in the UNET model).

Bank elevations are in feet (msl) as defined in PIE's UNET model
Estimated zero-damage stage at index cross-section (to be used for stage-damage evaluation)

Chehalis River Index Cross-Sections

Reach	Index Cross-Section	Estimated zero-damage elevation at Index Cross-Section
	(RM)	(feet - msl)
Chehalis 1	74.02	172.5
Chehalis 2	72.80	172.3
Chehalis 3	70.30	169.2
Chehalis 4	68.67	166.2
Chehalis 5	67.29	168.0
Chehalis 6	66.30	164.0
Chehalis 7	65.20	160.0

Skookumchuck River Index Cross-Sections

Reach	Index Cross-Section	Estimated zero-damage elevation at Index Cross-Section
	(RM)	(feet - msl)
Skookumchuck 1	10.56	240.6
Skookumchuck 2	5.08	201.5
Skookumchuck 3	2.415	184.5
Skookumchuck 4	0.98	173.0

The following information is to be used to characterize existing ("pre-project") conditions in the Chehalis River basin
Discharge-Probability Function Statistics to be input to HEC-FDA for Chehalis River Reaches
Use with "Graphical Type" Probability Function in HEC-FDA, Water Surface Profile Type is "Discharge-Probability"

Reach	Chehalis 1	Chehalis 2	Chehalis 3	Chehalis 4	Chehalis 5	Chehalis 6	Chehalis 7
Index Cross-Section (RM)	74.02	72.80	70.30	68.67	67.29	66.30	65.20
Equivalent Record Length (years)	70	70	70	70	70	70	70
Exceedance Probability	Discharge (cfs)	Discharge (cfs)	Discharge (cfs)	Discharge (cfs)	Discharge (cfs)	Discharge (cfs)	Discharge (cfs)
0.999	14,516	10,455	5,079	8,549	8,448	11,683	11,688
0.500	21,637	20,231	18,648	18,743	18,718	24,251	24,260
0.200	28,285	27,181	26,573	25,951	26,030	33,620	33,632
0.100	33,715	32,444	31,978	31,429	31,606	40,892	40,906
0.040	41,835	39,889	38,958	39,202	39,539	51,392	51,408
0.020	48,878	46,043	44,257	45,645	46,132	60,233	60,251
0.010	56,851	52,747	49,638	52,678	53,343	70,006	70,026
0.005	65,898	60,078	55,132	60,384	61,259	80,847	80,869
0.002	79,781	70,871	62,613	71,750	72,958	97,060	97,085
0.001	91,971	79,974	68,458	81,352	82,862	110,942	110,970

Discharge-Probability Function Statistics to be input to HEC-FDA for Skookumchuck River Reaches
Use with "Graphical Type" Probability Function in HEC-FDA, Water Surface Profile Type is "Discharge-Probability"

Reach	Skookumchuck 1	Skookumchuck 2	Skookumchuck 3	Skookumchuck 4
Index Cross-Section (RM)	10.56	5.08	2.42	0.98
Equivalent Record Length (years)	49	49	49	49
Exceedance Probability	Discharge (cfs)	Discharge (cfs)	Discharge (cfs)	Discharge (cfs)
0.999	573	549	976	1,029
0.500	3,200	3,200	4,050	4,200
0.200	5,109	5,170	6,508	6,713
0.100	6,525	6,645	8,471	8,712
0.040	8,470	8,683	11,358	11,642
0.020	10,025	10,321	13,819	14,133
0.010	11,666	12,057	16,562	16,903
0.005	13,402	13,900	19,620	19,987
0.002	15,856	16,515	24,212	24,606
0.001	17,841	18,638	28,152	28,561

Max. Water surface elevation in storage area for given flood event (ft)
Return Interval of event (probability of occurrence in parentheses)

Storage Area Number [1]	2-yr (0.50)	5-yr (0.20)	10-yr (0.10)	25-yr (0.04)	50-yr (0.02)	100-yr (0.01)	200-yr (0.005)	500-yr (0.002)	River Cross-section that storage area is hydraulically linked to [2]	Associated Economics Reach [3]	Associated Index Cross-Section [3]
102	N/A	176.24	178.22	181.09	181.82	182.31	183.03	183.83	Newaukum RM 0.08	Chehalis Econ. Reach 1	Chehalis RM 74.02
101	N/A	176.17	178.09	181.07	181.81	182.34	183.16	184.02	Newaukum RM 0.08	Chehalis Econ. Reach 1	Chehalis RM 74.02
100	N/A	176.16	178.07	181.94	182.39	182.72	183.48	184.43	Chehalis RM 76.70	Chehalis Econ. Reach 1	Chehalis RM 74.02
301	175.55	177.85	178.92	180.67	181.55	182.06	182.87	183.68	Dillenbaugh RM 0.623	Chehalis Econ. Reach 1	Chehalis RM 74.02
302	175.34	177.55	178.86	180.65	181.53	182.04	182.82	183.61	Dillenbaugh RM 0.623	Chehalis Econ. Reach 1	Chehalis RM 74.02
303	N/A	N/A	175.25	179.08	180.32	181.21	181.35	182.01	Chehalis RM 74.57	Chehalis Econ. Reach 1	Chehalis RM 74.02
2	N/A	N/A	N/A	N/A	175.42	176.13	177.51	179.24	Chehalis RM 72.80	Chehalis Econ. Reach 2	Chehalis RM 72.80
3	N/A	N/A	N/A	N/A	174.88	176.01	177.26	178.91	Salzer RM 1.56	Chehalis Econ. Reach 4	Chehalis RM 68.67
4	N/A	N/A	N/A	N/A	174.85	175.99	177.29	178.95	Salzer RM 1.28	Chehalis Econ. Reach 4	Chehalis RM 68.67
5	N/A	N/A	N/A	N/A	N/A	N/A	176.51	177.88	Chehalis RM 68.05	Chehalis Econ. Reach 4	Chehalis RM 68.67
501	N/A	169.67	171.35	173.33	174.77	175.64	176.98	178.62	Chehalis RM 68.67	Chehalis Econ. Reach 4	Chehalis RM 68.67
603	N/A	188.06	188.14	188.32	188.46	188.61	188.78	189.31	China Creek - N/A [4]	Not included	N/A
604	N/A	N/A	N/A	N/A	N/A	N/A	N/A	184.31	China Creek - N/A [4]	Not included	N/A
605	N/A	182.54	182.64	183.73	184.49	185.37	185.86	186.46	China Creek - N/A [4]	Not included	N/A
608	N/A	N/A	N/A	N/A	N/A	N/A	N/A	179.00	China Creek - N/A [4]	Not included	N/A
610	N/A	169.11	170.28	171.97	173.09	174.07	175.40	177.45	Chehalis RM 67.36	Chehalis Econ. Reach 5	Chehalis RM 67.29

1 - Storage Area number as related to the Chehalis UNET model and as delineated on the 1"=400' scale maps.
2 - Stream and river mile most closely associated with overflow to storage area.
3 - Economics reach and associated index cross-section that should be used to link the storage area to hydrologic (discharge-probability) and hydraulic (stage-discharge) information.
4 - Storage area is mostly flooded from China Creek (China Creek is not modeled hydraulically in the UNET model).
N/A - Storage Area is dry for the given event.

Max. Water surface elevation in storage area for given flood event (ft)
Return Interval of event (probability of occurrence in parentheses)

Storage Area Number [1]	3.1-yr (0.323)	6.1-yr (0.164)	12.7-yr (0.079)	34-yr (0.029)	50-yr (0.02)	88-yr (0.011)	143-yr (0.007)	482-yr (0.0021)	River Cross-section that storage area is hydraulically linked to [2]	Associated Economics Reach [3]	Associated Index Cross-Section [3]
601	N/A	186.29	188.12	188.32	188.46	188.60	188.77	189.63	Skookumchuck RM 2.99	Skookumchuck Econ. Reach 3	Skookumchuck RM 2.415
602	N/A	N/A	N/A	N/A	N/A	184.66	187.12	187.51	Skookumchuck RM 2.415	Skookumchuck Econ. Reach 3	Skookumchuck RM 2.415
606	N/A	N/A	N/A	N/A	N/A	N/A	179.06	179.61	Skookumchuck RM 2.00	Skookumchuck Econ. Reach 3	Skookumchuck RM 2.415
609	N/A	169.38	170.45	172.04	173.06	173.93	174.96	176.25	Skookumchuck RM 0.49	Skookumchuck Econ. Reach 4	Skookumchuck RM 0.98
701	N/A	N/A	200.61	201.19	201.49	201.76	202.00	202.62	Skookumchuck RM 5.08	Skookumchuck Econ. Reach 2	Skookumchuck RM 5.08
702	N/A	N/A	198.14	199.46	200.03	200.66	200.98	201.74	Skookumchuck RM 5.08	Skookumchuck Econ. Reach 2	Skookumchuck RM 5.08
703	N/A	N/A	194.10	194.80	195.14	195.53	195.79	196.37	Skookumchuck RM 5.08	Skookumchuck Econ. Reach 2	Skookumchuck RM 5.08
704	N/A	187.22	187.38	188.60	189.06	189.56	189.88	190.61	Skookumchuck RM 5.08	Skookumchuck Econ. Reach 2	Skookumchuck RM 5.08
705	N/A	183.70	184.33	185.70	185.98	186.32	186.51	187.12	Skookumchuck RM 2.00	Skookumchuck Econ. Reach 3	Skookumchuck RM 2.415

1 - Storage Area number as related to the Chehalis UNET model and as delineated on the 1"=400' scale maps.
2 - Stream and river mile most closely associated with overflow to storage area.
3 - Economics reach and associated index cross-section that should be used to link the storage area to hydrologic (discharge-probability) and hydraulic (stage-discharge) information.
N/A - Storage Area is dry for the given event.

Figure A.1 - Example of @RISK Spreadsheet

REACH 1														
1000				YR				0.50	21.05					
Reference X				74.02				1.00						
Reference X WS elev				183.00				4.50	95.00					

3.4.2.1.1.1.1.1.1 RESIDENTIAL STRUCTURES ON THE CHEHALIS

SHEET #	GRID	STRUCTURE #	SPOT ELEVATION	RIVER MILE	RIVER	REACH	STRUCTURE TYPE	SAMPLE ELEVATION ADJUSTMENT	TRUE ELEVATION	x-Section WS Elev	REFERENCE X ELEV	X ADJUSTMENT	R&U ELEVATION	INUNDATION DEPTH
L16	12	5	179.8	73.10	CH	1	R	1.80	181.60	182.27	183.00	0.73	182.33	0.67
M16	23	11	175.7	73.17	CH	1	R	1.80	177.50	182.29	183.00	0.71	178.21	4.79
M16	23	12	179.1	73.17	CH	1	R	1.80	180.90	182.29	183.00	0.71	181.61	1.39
M16	23	13	176.5	73.17	CH	1	R	1.80	178.30	182.29	183.00	0.71	179.01	3.99
M16	23	14	175.3	73.17	CH	1	R	1.80	177.10	182.29	183.00	0.71	177.81	5.19
M16	23	15	175.2	73.17	CH	1	R	1.80	177.00	182.29	183.00	0.71	177.71	5.29
M16	24	1	175.2	73.17	CH	1	R	1.80	177.00	182.29	183.00	0.71	177.71	5.29
M16	25	2	175.4	73.17	CH	1	R	1.80	177.20	182.29	183.00	0.71	177.91	5.09
L18	24	1	182.8	73.40	CH	1	R	1.80	184.60	182.44	183.00	0.56	185.16	-2.16
L18	24	2	183.4	73.40	CH	1	R	1.80	185.20	182.44	183.00	0.56	185.76	-2.76
M16	31	1	175.2	73.70	CH	1	R	1.80	177.00	182.64	183.00	0.36	177.36	5.64
M16	31	2	175.5	73.70	CH	1	R	1.80	177.30	182.64	183.00	0.36	177.66	5.34
M16	31	3	175.5	73.70	CH	1	R	1.80	177.30	182.64	183.00	0.36	177.66	5.34
M16	31	4	176.1	73.70	CH	1	R	1.80	177.90	182.64	183.00	0.36	178.26	4.74

Figure A.1 - Example of @RISK Spreadsheet

			LCM	1.11					
	MEAN:	1,524	CCM	1.04			3.65	1,537	3.01
	STD:	532	G	68.87	79.50		0.94	411	2.36
	MIN:	600	A	49.69	57.36		0.00	0	0.00
	MAX:	4,500	F	42.85	49.47		10.00	10,000	20.00
	SUM	327,147		20,319,262	8,163,972	4,460,322	1,136,720	276,680	960,628
STRUCTURE DAMAGE %	**CONTENT DAMAGE %**	**SQUARE FOOTAGE**	**M&S VALUE**	**STRUCTURE VALUE**	**STRUCTURE DAMAGE**	**CONTENT DAMAGE**	**CLEAN UP COSTS**	**TRA COSTS**	**PUBLIC ASSISTANCE**
0.1835	0.1070	1,573	62.11	97,689	17,926	10,453	5,741	1,537	5,337
0.5168	0.2803	1,573	62.11	97,689	50,481	27,377	5,741	1,537	5,337
0.2550	0.1445	1,573	62.11	97,689	24,911	14,116	5,741	1,537	5,337
0.4535	0.2478	1,573	62.11	97,689	44,302	24,202	5,741	1,537	5,337
0.5320	0.2880	1,573	62.11	97,689	51,970	28,134	5,741	1,537	5,337
0.5455	0.2948	1,573	62.11	97,689	53,289	28,794	5,741	1,537	5,337
0.5455	0.2948	1,573	62.11	97,689	53,289	28,794	5,741	1,537	5,337
0.5320	0.2880	1,573	62.11	97,689	51,970	28,134	5,741	1,537	5,337
0.0000	0.0000	1,573	62.11	97,689	0	0	0	0	0
0.0000	0.0000	1,573	62.11	97,689	0	0	0	0	0
0.5590	0.3015	1,573	62.11	97,689	54,608	29,453	5,741	1,537	5,337
0.5455	0.2948	1,573	62.11	97,689	53,289	28,794	5,741	1,537	5,337
0.5455	0.2948	1,573	62.11	97,689	53,289	28,794	5,741	1,537	5,337
0.5015	0.2725	1,573	62.11	97,689	48,991	26,620	5,741	1,537	5,337

APPENDIX B – STAGE-DAMAGE FUNCTIONS

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Chehalis Reach 1 - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
172.50	0	0	0	0	0	0	0	0	0	0	0	0
173.68	83	55	80	0	0	0	0	0	0	4	12	234
175.54	562	351	339	50	23	0	0	0	0	29	102	1,456
176.37	1,070	646	497	84	46	6	0	0	0	59	203	2,611
177.79	2,245	1,302	715	163	112	6	11	2	0	122	423	5,101
178.58	3,029	1,729	807	228	166	21	44	9	0	155	538	6,726
179.16	3,591	2,039	861	243	197	26	54	17	4	175	609	7,816
179.92	4,428	2,482	926	286	251	27	62	24	4	201	697	9,388
180.96	5,467	3,034	990	485	378	49	78	33	4	227	787	11,532
183.00	8,112	4,424	1,108	713	650	105	92	48	4	274	952	16,482
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	208	20,319										
Commercial	28	2,914	2,465	73,300								
Public	5	994	823	27,500								

Chehalis Reach 2 - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
172.30	0	0	0	0	0	0	0	0	0	0	0	0
172.34	38	24	26	0	0	0	0	0	0	2	7	97
174.47	7	1	0	7	1	0	0	0	0	10	36	62
175.32	347	205	136	10	2	0	0	0	0	18	64	782
176.77	698	399	188	28	12	0	0	0	0	36	123	1,484
177.53	925	521	210	43	24	9	0	0	0	44	152	1,928
178.12	1,122	627	224	44	34	9	0	0	0	50	173	2,283
178.89	1,381	764	237	53	42	9	0	0	0	56	195	2,737
180.06	1,756	960	248	65	55	9	0	0	0	63	217	3,373
182.50	2,408	1,295	263	81	79	9	0	0	0	68	236	4,439
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	52	5,080										
Commercial	3	214	181	7,300								
Public	0	0	0	0								

Chehalis Reach 3 - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
169.20	0	0	0	0	0	0	0	0	0	0	0	0
170.45	74	48	52	0	0	0	0	0	0	4	14	192
171.62	190	114	88	0	0	0	0	0	0	11	39	442
173.58	528	305	160	34	39	13	0	0	0	27	93	1,199
174.81	844	477	203	99	95	24	0	0	0	39	137	1,918
175.86	1,161	649	239	198	205	66	0	0	0	50	173	2,741
177.05	1,566	868	289	530	664	66	0	0	0	60	210	4,253
178.58	2,168	1,191	346	1,491	2,866	796	0	0	0	77	267	9,202
182.00	3,592	1,931	422	2,492	5,731	803	0	0	0	104	361	15,436
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	98	9,574										
Commercial	10	8,195	15,493	226,700								
Public	0	0	0	0								

Chehalis Reach 4 - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
166.20	0	0	0	0	0	0	0	0	0	0	0	0
166.90	13	8	7	0	0	0	0	0	0	1	3	32
169.82	69	41	26	46	32	0	2	2	0	3	10	231
171.17	141	84	65	66	75	0	5	5	0	6	21	468
173.22	550	337	311	174	146	16	8	9	0	25	85	1,661
174.50	1,304	788	626	293	263	26	8	11	0	65	226	3,610
175.59	2,477	1,461	954	572	485	82	337	211	4	128	445	7,156
176.81	4,395	2,531	1,312	903	830	156	499	463	106	223	774	12,192
178.36	7,657	4,302	1,676	1,210	1,284	228	729	698	120	349	1,214	19,467
181.50	15,182	8,266	2,025	1,795	2,102	255	2,623	2,412	506	511	1,777	37,454
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	365	35,656										
Commercial	37	5,120	4,087	108,700								
Public	12	11,883	11,593	141,000								

Chehalis Reach 5 - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
168.00	0	0	0	0	0	0	0	0	0	0	0	0
168.36	0	0	1	141	0	0	0	0	0	0	0	142
169.59	5	4	8	141	0	0	4	3	0	0	0	165
171.42	52	34	40	141	0	0	9	10	0	3	9	298
172.47	133	82	79	141	0	0	26	15	0	7	25	508
173.40	261	158	126	141	0	0	59	40	0	14	49	848
174.40	492	291	196	141	0	0	74	66	11	26	90	1,387
175.72	973	561	298	141	0	0	100	97	11	49	169	2,399
178.50	2,444	1,357	450	141	0	0	127	147	11	101	351	5,129
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	123	12,016										
Commercial	1	211	141	2,000								
Public	3	368	344	7,400								

Chehalis Reach 6 - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
164.00	0	0	0	0	0	0	0	0	0	0	0	0
164.10	15	12	29	0	0	0	0	0	0	0	1	57
165.28	103	71	111	18	12	0	0	0	0	4	15	334
167.03	660	410	393	39	44	15	25	17	7	36	125	1,771
167.96	1,354	816	619	54	62	15	59	52	7	74	255	3,367
168.81	2,302	1,351	834	59	75	15	207	129	12	123	427	5,534
169.81	3,616	2,078	1,040	313	160	15	379	283	76	185	643	8,788
171.06	5,624	3,162	1,224	430	281	117	488	437	84	262	910	13,019
173.00	8,992	4,937	1,348	655	432	117	627	650	84	339	1,178	19,359
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	272	26,571										
Commercial	4	2,258	1,298	33,500								
Public	10	2,120	1,898	32,400								

Chehalis Reach 7 - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
160.00	0	0	0	0	0	0	0	0	0	0	0	0
160.67	0	0	1	0	0	0	0	0	0	0	0	1
162.01	4	3	7	0	0	0	0	0	0	0	0	14
163.70	39	25	31	0	0	0	0	0	0	2	7	104
164.67	91	56	56	0	0	0	0	0	0	5	17	225
165.51	166	101	86	0	0	0	0	0	0	9	31	393
166.50	306	182	128	0	0	0	1,963	1,180	493	16	57	4,325
166.77	574	332	176	0	0	0	2,250	2,213	520	30	104	6,199
169.50	1,069	598	216	0	0	0	3,823	3,896	677	49	169	10,497
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	40	3,908										
Commercial	0	0	0	0								
Public	9	15,122	15,122	185,500								

Chehalis Storage Area 101 (Reference Reach 1) - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
172.50	0	0	0	0	0	0	0	0	0	0	0	0
173.68	0	0	0	0	0	0	0	0	0	0	0	0
175.54	1	1	1	0	0	0	0	0	0	0	0	3
176.37	8	5	4	0	0	0	0	0	0	0	2	19
177.79	30	17	6	0	0	0	0	0	0	1	5	59
178.58	36	20	6	0	0	0	0	0	0	1	5	68
179.16	40	22	6	0	0	0	0	0	0	2	5	75
179.92	45	24	6	0	0	0	0	0	0	2	5	82
180.96	50	27	6	0	0	0	0	0	0	2	5	90
183.00	60	32	6	0	0	0	0	0	0	2	5	105
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	1	98										
Commercial	0	0	0	0								
Public	0	0	0	0								

Chehalis Storage Area 102 (Reference Reach 1) - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
172.50	0	0	0	0	0	0	0	0	0	0	0	0
173.68	0	0	0	0	0	0	0	0	0	0	0	0
175.54	3	2	4	0	0	0	0	0	0	0	0	9
176.37	26	16	14	0	0	0	0	0	0	2	5	63
177.79	117	67	29	0	0	0	0	0	0	6	20	239
178.58	148	83	31	0	0	0	0	0	0	7	24	293
179.16	170	95	32	0	0	0	0	0	0	7	26	330
179.92	201	111	34	0	0	0	0	0	0	8	28	382
180.96	236	129	34	0	0	0	0	0	0	9	30	438
183.00	313	169	35	0	0	0	0	0	0	9	32	558
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	6	586										
Commercial	0	0	0	0								
Public	0	0	0	0								

Chehalis Storage Area 302 (Reference Reach 1) - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
172.50	0	0	0	0	0	0	0	0	0	0	0	0
173.68	5	3	3	357	243	146	0	0	0	0	1	758
175.54	21	13	11	507	550	146	0	0	0	1	4	1,253
176.37	59	38	49	648	796	157	0	0	0	2	7	1,756
177.79	313	197	202	793	1,080	165	0	0	0	15	54	2,819
178.58	621	377	309	956	1,206	165	0	0	0	33	116	3,783
179.16	864	517	372	993	1,283	165	0	0	0	48	166	4,408
179.92	1,337	781	458	1,062	1,413	165	0	0	0	73	254	5,543
180.96	1,911	1,095	530	1,094	1,567	176	0	0	0	100	347	6,820
183.00	3,599	1,993	622	1,215	1,745	176	0	0	0	151	525	10,026
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	111	10,844										
Commercial	7	2,788	3,165	57,700								
Public	0	0	0	0								

Chehalis Storage Area 303 (Reference Reach 1) - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
172.50	0	0	0	0	0	0	0	0	0	0	0	0
173.68	0	0	0	0	0	0	0	0	0	0	0	0
175.54	0	0	0	0	0	0	0	0	0	0	0	0
176.37	13	9	12	0	0	0	0	0	0	1	2	37
177.79	216	125	68	0	0	0	0	0	0	11	40	460
178.58	352	199	82	0	0	0	0	0	0	17	59	709
179.16	456	254	88	0	0	0	0	0	0	20	70	888
179.92	474	263	89	0	0	0	0	0	0	21	71	918
180.96	554	306	91	0	0	0	0	0	0	22	77	1,050
183.00	780	423	96	0	0	0	0	0	0	25	87	1,411
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	17	1,661										
Commercial	0	0	0	0								
Public	0	0	0	0								

Chehalis Storage Area 2 (Reference Reach 2) - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
172.30	0	0	0	0	0	0	0	0	0	0	0	0
172.34	0	0	0	0	0	0	0	0	0	0	0	0
174.47	0	0	0	0	0	0	0	0	0	0	0	0
175.32	0	0	0	0	0	0	0	0	0	0	0	0
176.77	0	0	0	0	0	0	0	0	0	0	0	0
177.53	465	258	89	3,088	4,346	621	444	594	9	19	65	9,998
178.12	549	305	104	3,712	5,494	912	488	643	9	21	71	12,308
178.89	755	418	143	4,217	7,245	924	562	763	9	26	92	15,154
180.06	1,111	612	194	5,542	9,576	1,089	613	881	17	40	137	19,812
182.50	1,739	942	235	6,713	12,540	1,089	662	940	17	58	200	25,135
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	42	4,103										
Commercial	31	16,640	25,337	384,800								
Public	13	1,472	1,657	60,900								

Chehalis Storage Area 3 (Reference Reach 4) - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
166.20	0	0	0	0	0	0	0	0	0	0	0	0
166.90	0	0	0	0	0	0	0	0	0	0	0	0
169.82	0	0	0	0	0	0	0	0	0	0	0	0
171.17	0	0	0	0	0	0	0	0	0	0	0	0
173.22	0	0	0	0	0	0	0	0	0	0	0	0
174.50	507	283	115	1,178	1,035	176	2,663	1,843	226	19	65	8,110
175.59	696	388	152	1,713	1,838	502	2,834	1,980	249	27	93	10,472
176.81	972	537	186	2,483	2,701	508	2,959	2,078	249	38	132	12,843
178.36	1,381	752	210	3,359	4,009	769	3,100	2,150	249	50	175	16,204
181.50	2,088	1,113	218	4,750	6,123	772	3,277	2,198	249	58	202	21,048
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	38	3,712										
Commercial	30	12,297	13,005	262,200								
Public	55	6,716	3,705	193,400								

Chehalis Storage Area 4 (Reference Reach 4) - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
166.20	0	0	0	0	0	0	0	0	0	0	0	0
166.90	0	0	0	0	0	0	0	0	0	0	0	0
169.82	0	0	0	0	0	0	0	0	0	0	0	0
171.17	0	0	0	0	0	0	0	0	0	0	0	0
173.22	0	0	0	0	0	0	0	0	0	0	0	0
174.50	112	65	37	4,922	7,003	1,739	0	0	0	6	21	13,905
175.59	182	104	50	6,405	9,933	1,874	0	0	0	9	30	18,587
176.81	284	160	64	7,829	13,049	1,957	0	0	0	12	43	23,398
178.36	440	243	75	9,337	16,785	2,096	0	0	0	17	61	29,054
181.50	722	389	80	11,973	22,813	2,105	0	0	0	21	74	38,177
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	14	1,368										
Commercial	52	28,277	42,101	657,200								
Public	0	0	0	0								

Chehalis Storage Area 5 (Reference Reach 4) - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
166.20	0	0	0	0	0	0	0	0	0	0	0	0
166.90	0	0	0	0	0	0	0	0	0	0	0	0
169.82	0	0	0	0	0	0	0	0	0	0	0	0
171.17	0	0	0	0	0	0	0	0	0	0	0	0
173.22	0	0	0	0	0	0	0	0	0	0	0	0
174.50	0	0	0	0	0	0	0	0	0	0	0	0
175.59	0	0	0	0	0	0	0	0	0	0	0	0
176.81	6,533	3,650	1,307	712	1,110	149	74	82	11	286	992	14,906
178.36	8,996	4,948	1,407	853	1,518	149	80	102	11	345	1,198	19,607
181.50	13,835	7,425	1,441	1,216	2,236	149	114	141	11	385	1,339	28,292
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	251	24,520										
Commercial	6	3,016	4,715	40,900								
Public	1	263	263	3,000								

Chehalis Storage Area 610B (Reference Reach 5) - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
168.00	0	0	0	0	0	0	0	0	0	0	0	0
168.36	66	44	63	106	32	0	0	0	0	3	10	324
169.59	218	138	149	212	96	73	10	7	0	11	39	953
171.42	795	481	388	401	225	96	436	310	0	42	146	3,320
172.47	1,574	933	639	580	363	112	668	729	128	81	283	6,090
173.40	2,622	1,528	892	742	513	118	945	1,016	135	132	459	9,102
174.40	4,607	2,623	1,192	949	704	131	1,926	1,858	154	222	772	15,138
175.72	8,393	4,643	1,445	1,214	978	131	2,740	3,208	373	343	1,190	24,658
178.50	13,209	7,133	1,510	1,743	1,427	218	3,609	4,777	373	400	1,391	35,790
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	264	25,790										
Commercial	15	4,928	3,276	72,700								
Public	7	10,194	10,675	115,700								

Skookumchuck Reach 1 - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
240.60	0	0	0	0	0	0	0	0	0	0	0	0
240.68	231	143	127	116	79	47	41	8	11	14	47	864
241.74	466	273	164	116	133	47	50	12	11	28	99	1,399
242.17	575	333	175	140	156	47	93	34	11	33	116	1,713
242.60	691	395	185	165	179	47	131	56	27	38	131	2,045
242.97	794	450	190	170	190	47	132	64	27	41	143	2,248
243.60	973	545	198	185	222	47	177	94	27	46	161	2,675
247.00	1,802	974	201	275	358	47	351	210	49	54	187	4,508
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	35	3,419										
Commercial	2	667	754	13,000								
Public	3	1,102	565	13,500								

Skookumchuck Reach 2 - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
201.50	0	0	0	0	0	0	0	0	0	0	0	0
202.01	112	71	71	0	0	0	0	0	0	6	21	281
202.89	212	128	97	0	0	0	0	0	0	12	43	492
203.62	324	190	115	0	0	0	0	0	0	19	65	713
203.92	376	218	121	0	0	0	0	0	0	21	75	811
204.19	456	262	130	0	0	0	0	0	0	25	87	960
204.43	529	301	135	0	0	0	0	0	0	28	97	1,090
204.81	670	377	143	0	0	0	0	0	0	32	112	1,334
206.70	1,044	572	149	0	0	0	0	0	0	39	135	1,939
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	26	2,540										
Commercial	0	0	0	0								
Public	0	0	0	0								

Skookumchuck Reach 4 - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
173.00	0	0	0	0	0	0	0	0	0	0	0	0
173.77	285	165	101	688	226	0	5	1	1	13	45	1,530
174.36	382	224	155	916	398	256	6	1	1	16	56	2,411
175.21	806	483	388	1,507	964	304	8	2	1	34	118	4,615
175.84	1,095	663	556	1,843	1,270	324	8	2	1	49	170	5,981
176.39	1,690	1,021	826	3,039	2,441	486	8	2	1	81	279	9,874
176.90	2,418	1,444	1,059	3,442	3,489	833	543	324	129	120	417	14,218
177.69	4,219	2,471	1,533	4,279	4,932	833	600	590	129	212	737	20,535
181.00	14,608	8,132	2,819	6,701	8,815	921	1,483	1,681	220	621	2,160	48,161
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	619	60,469										
Commercial	35	19,218	21,620	377,550								
Public	4	5,294	5,273	60,400								

Skookumchuck Storage Area 701 (Reference Reach 2) - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
201.50	0	0	0	0	0	0	0	0	0	0	0	0
202.01	0	0	0	0	0	0	0	0	0	0	0	0
202.89	19	12	13	0	0	0	0	0	0	1	4	49
203.62	31	19	16	0	0	0	0	0	0	2	7	75
203.92	38	23	17	0	0	0	0	0	0	2	8	88
204.19	46	27	18	0	0	0	0	0	0	3	10	104
204.43	52	31	18	0	0	0	0	0	0	3	11	115
205.04	70	41	20	0	0	0	0	0	0	4	14	149
206.70	123	69	23	0	0	0	0	0	0	6	19	240
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	4	391										
Commercial	0	0	0	0								
Public	0	0	0	0								

Skookumchuck Storage Area 702 (Reference Reach 2) - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
201.50	0	0	0	0	0	0	0	0	0	0	0	0
202.01	0	0	0	0	0	0	0	0	0	0	0	0
202.89	307	191	180	0	0	0	0	0	0	17	58	753
203.62	755	446	288	0	0	0	0	0	0	43	147	1,679
203.92	1,014	589	329	0	0	0	0	0	0	56	194	2,182
204.19	1,334	764	364	0	0	0	0	0	0	70	243	2,775
204.43	1,510	858	379	0	0	0	0	0	0	77	266	3,090
205.04	1,939	1,088	407	0	0	0	0	0	0	91	315	3,840
206.70	2,878	1,581	432	2	2	0	0	0	0	110	382	5,387
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	76	7,424										
Commercial	1	51	58	1,000								
Public	0	0	0	0								

Skookumchuck Storage Area 703 (Reference Reach 2) - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
201.50	0	0	0	0	0	0	0	0	0	0	0	0
202.01	0	0	0	0	0	0	0	0	0	0	0	0
202.89	68	47	75	13	7	1	0	0	0	3	9	223
203.62	156	103	131	24	15	1	0	0	0	8	26	464
203.92	221	142	164	24	17	1	0	0	0	11	40	620
204.19	317	200	207	25	21	1	0	0	0	17	59	847
204.43	394	245	236	27	23	1	0	0	0	22	75	1,023
205.04	614	374	309	32	27	1	0	0	0	34	118	1,509
206.70	1,601	927	505	39	38	1	0	0	0	86	297	3,494
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	118	11,527										
Commercial	2	137	116	1,700								
Public	0	0	0	0								

Skookumchuck Storage Area 704 (Reference Reach 2) - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
201.50	0	0	0	0	0	0	0	0	0	0	0	0
202.01	3	2	3	0	0	0	0	0	0	0	1	9
202.89	4	3	3	0	0	0	0	0	0	0	1	11
203.62	13	8	9	0	0	0	0	0	0	1	2	33
203.92	19	12	14	0	0	0	0	0	0	1	3	49
204.19	30	19	23	0	0	0	0	0	0	1	5	78
204.43	41	26	31	0	0	0	0	0	0	2	6	106
205.04	78	50	57	0	0	0	0	0	0	3	12	200
206.70	299	182	150	0	0	0	9	5	0	16	55	716
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	74	7,229										
Commercial	3	437	511	7,200								
Public	3	3,271	3,271	38,800								

Skookumchuck Storage Area 602 (Reference Reach 3) - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
184.50	0	0	0	0	0	0	0	0	0	0	0	0
185.19	0	0	0	0	0	0	0	0	0	0	0	0
185.89	0	0	0	0	0	0	0	0	0	0	0	0
186.65	0	0	0	0	0	0	0	0	0	0	0	0
187.06	0	0	0	0	0	0	0	0	0	0	0	0
187.56	19	14	34	0	0	0	0	0	0	0	1	68
187.79	544	349	392	141	113	14	53	30	11	28	96	1,771
188.07	778	488	479	185	157	32	53	41	11	42	146	2,412
189.50	2,072	1,218	751	359	355	64	75	68	11	120	416	5,509
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	173	16,900										
Commercial	13	2,104	2,277	44,900								
Public	4	1,079	473	18,000								

Skookumchuck Storage Area 606 (Reference Reach 3) - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
184.50	0	0	0	0	0	0	0	0	0	0	0	0
185.19	0	0	0	0	0	0	0	0	0	0	0	0
185.89	0	0	0	0	0	0	0	0	0	0	0	0
186.65	0	0	0	0	0	0	0	0	0	0	0	0
187.06	0	0	0	0	0	0	0	0	0	0	0	0
187.56	0	0	0	0	0	0	0	0	0	0	0	0
187.79	347	222	247	0	0	0	448	269	0	17	60	1,610
188.07	562	351	338	0	0	0	598	420	146	30	104	2,549
189.50	1,512	898	614	13	12	5	785	762	146	83	289	5,119
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	259	25,301										
Commercial	4	355	434	8,300								
Public	1	3,434	3,434	40,000								

Skookumchuck Storage Area 705 (Reference Reach 3) - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
184.50	0	0	0	0	0	0	0	0	0	0	0	0
185.19	6	4	7	10	7	0	0	0	0	0	1	35
185.89	13	9	14	20	16	0	0	0	0	1	2	75
186.65	57	37	42	24	27	0	0	0	0	3	10	200
187.06	74	47	52	26	29	0	0	0	0	4	13	245
187.56	99	63	66	29	33	0	0	0	0	5	18	313
187.79	117	73	75	30	35	0	0	0	0	6	21	357
188.07	190	117	109	32	38	0	0	0	0	10	34	530
189.50	494	293	202	35	49	0	0	0	0	26	91	1,190
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	67	6,545										
Commercial	1	115	130	5,000								
Public	0	0	0	0								

Skookumchuck Storage Area 609 (Reference Reach 4) - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
173.00	0	0	0	0	0	0	0	0	0	0	0	0
173.77	75	47	46	0	0	0	0	0	0	4	13	185
174.36	168	101	83	0	0	0	0	0	0	9	30	391
175.21	431	253	161	0	0	0	0	0	0	22	78	945
175.84	705	408	227	0	0	0	0	0	0	35	120	1,495
176.39	1,016	582	287	0	0	0	0	0	0	48	168	2,101
176.90	1,472	832	355	0	0	0	0	0	0	67	232	2,958
177.69	2,157	1,202	421	0	0	0	0	0	0	90	314	4,184
181.00	4,006	2,168	485	0	0	0	0	0	0	126	438	7,223
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	85	8,304										
Commercial	0	0	0	0								
Public	0	0	0	0								

Skookumchuck Reach 3 - Damages in $1,000												
	Residential			Commercial			Public					
Stage	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA	TOTAL
184.50	0	0	0	0	0	0	0	0	0	0	0	0
185.19	358	230	269	324	394	91	0	0	0	17	58	1,741
185.89	838	522	507	638	697	106	0	0	0	42	147	3,499
186.65	1,671	1,014	825	810	983	109	0	0	0	90	312	5,814
187.06	2,244	1,349	1,018	893	1,130	109	0	0	0	122	424	7,288
187.56	3,387	2,002	1,314	1,059	1,346	109	0	0	0	184	641	10,042
187.79	4,534	2,646	1,540	1,198	1,496	109	0	0	0	244	849	12,617
188.07	6,534	3,750	1,840	1,402	1,827	109	0	0	0	347	1,208	17,016
189.50	10,630	5,941	2,101	1,563	2,157	109	0	0	0	484	1,683	24,668
	Structure #	Value in $1,000		Square								
		Structure	Content	Feet								
Residential	383	37,415										
Commercial	7	4,484	4,344	115,800								
Public	7	5,531	5,655	69,500								

APPENDIX C – AGRICULTURAL DATA

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TABLE 1D. 1997 SCHEDULE OF OPERATIONS AND ESTIMATED COSTS PER ACRE FOR PRODUCTION OF ALFALFA HAY IN THE COLUMBIA BASIN; CENTER PIVOT IRRIGATION.

						VARIABLE COST						
OPERATION	TOOLING	MTH YEAR	MACH HOURS	LABOR HOURS	TOTAL FIXED COST	FUEL, LUBE, & REPAIRS	LABOR	SERVICE	MATER.	INTER.	TOTAL VARIABLE COST	TOTAL COST
					$	$	$	$	$	$	$	$
FERTILIZE*	CUSTOM APPLICATION	NOV 1996	.00	.00	.00	.00	.00	3.33	30.73	3.12	37.19	37.19
WEED CONTROL	CUSTOM HERBICIDE APPLIC.	MAR 1997	.00	.00	.00	.00	.00	5.50	15.75	1.24	22.49	22.49
IRRIGATION	CENTER PIVOT, 42 AC. IN.	SEA 1997	.00	1.00	.00	12.00	12.00	105.50	.00	6.48	135.97	135.97
SWATH	70HP/14' WINDROWER	MAY 1997	.17	.20	5.21	4.43	2.40	.00	.00	.28	7.11	12.32
RAKE & TURN	85HP-WT, 18' TWO-ROW RAKE	MAY 1997	.06	.07	1.42	.90	.81	.00	.00	.07	1.77	3.19
BALE	150HP-WT, PTO BALER	MAY 1997	.20	.24	9.74	4.65	2.88	.00	3.36	.45	11.34	21.08
REMOVE & STACK	CUSTOM BALE WAGON	MAY 1997	.00	.00	.00	.00	.00	12.50	.00	.52	13.02	13.02
SWATH	70HP/14' WINDROWER	JUL 1997	.14	.17	4.47	3.80	2.06	.00	.00	.15	6.00	10.47
RAKE & TURN	85HP-WT, 18' TWO-ROW RAKE	JUL 1997	.06	.07	1.42	.90	.81	.00	.00	.04	1.75	3.16
REMOVE & STACK	CUSTOM BALE WAGON	JUL 1997	.00	.00	.00	.00	.00	10.00	.00	.25	10.25	10.25
BALE	150HP-WT, PTO BALER	JUL 1997	.17	.20	8.13	3.88	2.40	.00	2.69	.22	9.19	17.32
SWATH	70HP/14' WINDROWER	AUG 1997	.14	.17	4.47	3.80	2.06	.00	.00	.10	5.95	10.43
RAKE & TURN	85HP-WT, 18' TWO-ROW RAKE	AUG 1997	.06	.07	1.42	.90	.81	.00	.00	.03	1.73	3.15
REMOVE & STACK	CUSTOM BALE WAGON	AUG 1997	.00	.00	.00	.00	.00	10.00	.00	.17	10.17	10.17
BALE	150HP-WT, PTO BALER	AUG 1997	.17	.20	8.13	3.88	2.40	.00	2.69	.15	9.12	17.25
SWATH	70HP/14' WINDROWER	OCT 1997	.14	.17	4.47	3.80	2.06	.00	.00	.00	5.86	10.33
RAKE & TURN	85HP-WT, 18' TWO-ROW RAKE	OCT 1997	.06	.07	1.42	.90	.81	.00	.00	.00	1.70	3.12
REMOVE & STACK	CUSTOM BALE WAGON	OCT 1997	.00	.00	.00	.00	.00	7.50	.00	.00	7.50	7.50
BALE	150HP-WT, PTO BALER	OCT 1997	.14	.17	6.96	3.32	2.06	.00	2.02	.00	7.40	14.36
GOPHER CONTROL	COST OF ANNUAL GOPHER CONTROL	ANN 1997	.00	.00	.00	.00	.00	2.00	.00	.10	2.10	2.10
PICK-UP	3/4 TON	ANN 1997	1.00	.00	5.68	3.07	.00	.00	.00	.15	3.23	8.91
OVERHEAD	UTILITIES, LEGAL, ACCT., ETC.	ANN 1997	.00	.00	.00	.00	.00	23.31	.00	.00	23.31	23.31
LAND COST	NET RENT	ANN 1997	.00	.00	250.00	.00	.00	.00	.00	.00	.00	250.00
MANAGEMENT	7% OF EXPECTED GROSS RETURNS	ANN 1997	.00	.00	61.60	.00	.00	.00	.00	.00	.00	61.60
ESTABLISHMENT**	PRORATED ESTABLISHMENT COST	ANN 1997	.00	.00	94.32	.00	.00	.00	.00	.00	.00	94.32
TOTAL PER ACRE			2.50	2.80	468.84	50.22	33.54	179.65	57.24	13.53	334.17	803.01

*TWO-THIRDS OF APPLIED COST SINCE FERTILIZER NOT APPLIED FIRST YEAR OF PRODUCTION.

**$234.57 ESTABLISHMENT COST AMORTIZED OVER 3 YEARS AT 10% INTEREST.

TABLE 1C. 1997 SCHEDULE OF OPERATIONS AND ESTIMATED COSTS PER ACRE FOR ESTABLISHING ALFALFA HAY FOLLOWING WHEAT OR BARLEY IN THE COLUMBIA BASIN; CENTER PIVOT IRRIGATION.*

						VARIABLE COST						
OPERATION	TOOLING	MTH	YEAR	MACH HOURS	LABOR HOURS	TOTAL FIXED COST	FUEL, LUBE, & REPAIRS	LABOR	SERVICE	MATER.	INTER.	TOTAL VARIABLE COST	TOTAL COST
						$	$	$	$	$	$	$	$
FERTILIZE**	CUSTOM APPLICATION	AUG	1996	.00	.00	.00	.00	.00	5.00	50.40	.92	56.32	56.32
DISC & PACK	150HP-WT, 13' TANDUM DISC&PACK	AUG	1996	.20	.24	8.92	3.96	2.88	.00	.00	.11	6.95	15.87
CHISEL	200HP-WT, 13' CHISEL	AUG	1996	.20	.24	10.26	4.80	2.88	.00	.00	.13	7.81	18.07
DISC & PACK	150HP-WT, 13' TANDUM DISK&PACK	AUG	1996	.20	.24	8.92	3.96	2.88	.00	.00	.11	6.95	15.87
HARROW	150HP-WT, 36' HARROW	AUG	1996	.07	.08	2.53	1.07	.96	.00	.00	.03	2.07	4.59
PLANT	150HP-WT, RENTED AIR SEEDER	AUG	1996	.17	.25	5.35	2.35	3.00	6.00	61.60	1.22	74.16	79.52
IRRIGATE	CENTER PIVOT; 6 AC. IN.	SEP	1996	.00	.17	.00	2.00	2.04	16.80	.00	.17	21.01	21.01
PICK-UP	3/4 TON	ANN	1996	.40	.48	2.27	1.23	5.76	.00	.00	.35	7.34	9.61
OVERHEAD	UTILITIES,LEGAL,ACCT.,ETC.	ANN	1996	.00	.00	.00	.00	.00	13.70	.00	.00	13.70	13.70
TOTAL PER ACRE				1.23	1.70	38.24	19.37	20.40	41.50	112.00	3.05	196.32	234.57

*ALL FIXED COSTS ASSOCIATED WITH LAND & MANAGEMENT ARE ALLOCATED TO THE PRECEDING CROP.

**ASSUMES THAT THE STRAW HAS BEEN REMOVED FIRST.

TABLE 1. SCHEDULE OF OPERATIONS AND ESTIMATED COSTS PER ACRE
1990 GREEN PEA PRODUCTION COSTS
NORTHWEST WASHINGTON, 100 ACRES ON A 250-ACRE FARM

OPERATION	TOOLING	MTH	YEAR	MACH HOURS	LABOR HOURS	TOTAL FIXED COST	VARIABLE COST					TOTAL VARIABLE COST	TOTAL COST
							FUEL, LUBE, & REPAIRS	MACH LABOR	SERVICE	MATER.	INTER.		
						$	$	$	$	$	$	$	$
DISK	130 HP, 15' DISK	SEP	1989	.14	.17	6.02	3.68	1.50	.00	.00	.57	5.75	11.77
CHISEL	130 HP, 10' CHISEL	SEP	1989	.21	.25	7.21	3.15	2.25	.00	.00	.59	5.98	13.20
LIMING	CUSTOM INCLUDES .75 TON L	MAR	1990	.00	.00	.00	.00	.00	17.25	.00	.86	18.11	18.11
FERTILIZE	CUSTOM BROADCAST[1]	APR	1990	.00	.00	.00	.00	.00	5.25	91.20	3.86	100.31	100.31
PLOW	130HP;MB 4-16 2WY	APR	1990	.39	.47	18.62	9.45	4.21	.00	.00	.55	14.21	32.83
CULTIVATE	130 HP, 15' CULTIVATOR	APR	1990	.23	.28	6.80	4.00	2.50	.00	.00	.26	6.76	13.56
CULTIMULCH	130 HP, 13' CULTIMULCHER	APR	1990	.16	.19	5.58	2.71	1.73	.00	.00	.18	4.62	10.20
WEED CONTROL	CUSTOM SPRAY[2]	APR	1990	.00	.00	.00	.00	.00	7.25	8.48	.63	16.36	16.36
WEED CONTROL	CUSTOM SPRAY[3]	MAY	1990	.00	.00	.00	.00	.00	7.25	19.00	.79	27.04	27.04
CULTIVATE	130HP; 15'CULTIVATOR	MAY	1990	.11	.14	3.40	2.00	1.25	.00	.00	.10	3.35	6.75
CULTIMULCH	130HP;13' CULTIMULCHER 2X	MAY	1990	.32	.38	11.15	5.43	3.46	.00	.00	.27	9.15	20.30
PLANT	60 HP, 10' DRILL DISK	MAY	1990	.28	.33	11.46	2.76	2.99	.00	71.10	2.31	79.16	90.62
INSECT CONT	CUSTOM 2X11[4]	MAY	1990	.00	.00	.00	.00	.00	7.25	2.48	.29	10.02	10.02
HARVEST	BY PROCESSOR	JUL	1990	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
CULTIVATE	130 HP,15' CULTIVATOR	AUG	1990	.11	.14	3.40	2.00	1.25	.00	.00	.00	3.25	6.65
DISK	130HP,15'DISK 2X	AUG	1990	.28	.33	12.04	7.36	2.99	.00	.00	.00	10.36	22.40
LAND RENT	LAND RENT	ANN	1990	.00	.00	140.00	.00	.00	.00	.00	.00	.00	140.00
OVERHEAD	5% VARIABLE COSTS	ANN	1990	.00	.00	.00	.00	.00	16.72	.00	.00	16.72	16.72
PICK-UP TRUCK	USED, THIS CROP	ANN	1990	.00	.00	.00	.00	.00	18.80	.00	1.13	19.93	19.93
TOTAL PER ACRE				2.22	2.68	225.69	42.54	24.12	79.77	192.26	12.37	351.07	576.76

[1] 570 LB/AC 4-24-21.
[2] .33 LB/AC SENCOR 75%DF.
[3] .25 GAL/AC BASAGRAN 4EC.
[4] .5 PT/AC AQUA8 PARATHION; TWO APPLICATIONS: 10% BLOOM AND 100% BLOOM; 1/2 PAID BY PROCESSOR.

TABLE 1. SCHEDULE OF OPERATIONS AND ESTIMATED COSTS PER ACRE
1990 SWEET CORN PRODUCTION COSTS
NORTHWEST WASHINGTON 50 ACRES ON 250 ACRE FARM

OPERATION	TOOLING	MTH	YEAR	MACH HOURS	LABOR HOURS	TOTAL FIXED COST	VARIABLE COST: FUEL, LUBE, & REPAIRS	VARIABLE COST: MACH LABOR	VARIABLE COST: SERVICE	VARIABLE COST: MATER.	VARIABLE COST: INTER.	TOTAL VARIABLE COST	TOTAL COST
						$	$	$	$	$	$	$	$
DISK	130HP, 15' DISK	OCT	1989	.14	.17	6.02	3.68	1.50	.00	.00	.52	5.70	11.72
SUBSOIL	130HP, SUBSOILER	OCT	1989	.39	.48	15.10	7.14	4.28	.00	.00	1.04	11.46	26.56
DISK	130HP, 15' DISK 2X	MAR	1990	.28	.33	12.04	7.36	2.99	.00	.00	.52	10.87	22.92
LIMING	CUST LIMING, INCL. 1T LIME	MAR	1990	.00	.00	.00	.00	.00	23.00	.00	1.15	24.15	24.15
PLOW	130HP, 4-16 PLOW	MAR	1990	.39	.47	18.62	9.45	4.21	.00	.00	.68	14.34	32.97
FERTILIZE	CUSTOM FERT. APPLICATION[1]	APR	1990	.00	.00	.00	.00	.00	5.25	24.34	1.18	30.77	30.77
CULTIMULCH	130HP, 13' CULTIMULCHER	APR	1990	.16	.19	5.58	2.71	1.73	.00	.00	.18	4.62	10.20
WEED CONTROL	WEED CONTROL 60HP[2]	APR	1990	.38	.46	14.93	1.86	4.16	.00	23.63	1.19	30.84	45.77
PLANT	CUSTOM PLANTING[3]	APR	1990	.00	.00	.00	.00	.00	15.00	89.00	4.16	108.16	108.16
CULTIVATE	60HP,4R CULTIVATOR	MAY	1990	.18	.22	7.80	.90	2.00	.00	.00	.09	2.98	10.78
FERTILIZE	60HP,CULTVTR/FERT ATT.[4]	JUN	1990	.21	.25	10.41	1.28	2.29	.00	24.00	.55	28.12	38.53
HARVEST	BY PROCESSOR	AUG	1990	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
PICKUP TRUCK	USED, THIS CROP	ANN	1990	.00	.00	.00	.00	.00	18.80	.00	1.13	19.93	19.93
LAND RENT	LAND RENT	ANN	1990	.00	.00	150.00	.00	.00	.00	.00	.00	.00	150.00
OVERHEAD	5% VARIABLE COST	ANN	1990	.00	.00	.00	.00	.00	14.60	.00	.00	14.60	14.60
TOTAL PER ACRE				2.13	2.57	240.50	33.38	23.16	76.65	160.98	12.38	306.55	547.05

[1] 220 LB/AC 0-0-60; 6 LB/AC ZINC.
[2] .5 GAL/AC SURPASS 6.7E; .375 GAL/AC ATRAZINE 4L.
[3] BAND APPLICATION OF 300 LB/AC 18-46-0.
[4] 200 LB/AC AMMONIUM NITRATE.

HAY		First Cycle							Second Cycle						
	NPV	Est.	1	2	3	4	5	6	Est.	1	2	3	4	5	6
NO FLOOD	$246.18	-263.55	86.91	86.91	86.91	86.91	86.91	86.91	-263.55	86.91	86.91	86.91	86.91	86.91	86.91
FLOOD DURING															
ESTABLISH	($50.72)	-263.55	-263.55	86.91	86.91	86.91	86.91	86.91	86.91	-263.55	86.91	86.91	86.91	86.91	86.91
1st	($50.72)	-263.55	-263.55	86.91	86.91	86.91	86.91	86.91	86.91	-263.55	86.91	86.91	86.91	86.91	86.91
2nd	($20.12)	-263.55	86.91	-263.55	86.91	86.91	86.91	86.91	86.91	86.91	-263.55	86.91	86.91	86.91	86.91
3rd	$8.65	-263.55	86.91	86.91	-263.55	86.91	86.91	86.91	86.91	86.91	86.91	-263.55	86.91	86.91	86.91
4th	$35.70	-263.55	86.91	86.91	86.91	-263.55	86.91	86.91	86.91	86.91	86.91	86.91	-263.55	86.91	86.91
5th	$61.12	-263.55	86.91	86.91	86.91	86.91	-263.55	86.91	86.91	86.91	86.91	86.91	86.91	-263.55	86.91
6th	$195.97	-263.55	86.91	86.91	86.91	86.91	86.91	-263.55	86.91	86.91	86.91	86.91	86.91	86.91	0.00
Average NPV	$25.70														
Loss per Acre	$220.48														

Sweet Corn												
Yield	6.5	tons										
Flood Probability	0.00%	0.00%	15.00%	31.67%	25.00%	18.33%	6.67%	3.33%	0.00%	0.00%	0.00%	0.00%
Month	9	10	11	12	1	2	3	4	5	6	7	8
Variable Cost	0.00	38.28	0.00	0.00	0.00	0.00	80.04	194.90	10.78	38.53	0.00	0.00
Cumulative Cost	0.00	38.28	38.28	38.28	38.28	38.28	118.32	313.22	324.00	362.53	362.53	362.53
Weighted Loss	0.00	0.00	5.74	12.12	9.57	7.02	7.89	10.43	0.00	0.00	0.00	0.00
TOTAL WEIGHTED LOSS	$52.77											

Green Pea												
Yield	2.5	tons										
Flood Probability	0.00%	0.00%	0.00%	15.00%	31.67%	25.00%	18.33%	6.67%	3.33%	0.00%	0.00%	0.00%
Month	8	9	10	11	12	1	2	3	4	5	6	7
Variable Cost	29.05	24.97	0.00	0.00	0.00	0.00	0.00	18.11	173.26	154.73	0.00	0.00
Cumulative Cost	29.05	54.02	54.02	54.02	54.02	54.02	54.02	72.13	245.39	400.12	400.12	400.12
Weighted Loss	0.00	0.00	0.00	8.10	17.11	13.51	9.90	4.81	8.17	0.00	0.00	0.00
TOTAL WEIGHTED LOSS	$61.60											

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APPENDIX D – WSDOT DATA/CORRESPONDENCE

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Location Project Design Estimate			MP 76.7 to MP 81.6 (2' Freeboard)			
			NO-RAISE OPTION		RAISE OPTION	
ITEM	UNIT	UNIT COST	QUANTITY	COST	QUANTITY	COST
Earthwork						
GRAVEL BORROW INCL. HAUL	TON	$6	1,032,277	$6,193,660	2,152,540	$12,915,239
EMBANKMENT COMPACTION	CY	$1	557,987	$557,987	1,163,535	$1,163,535
Surfacing						
CRUSHED SURFACING BASE COURSE	TON	$15	109,612	$1,644,176	200720	$3,010,804
ASPHALT CONC. PAVEMENT CL. A	TON	$35	58,067	$2,032,336	86274	$3,019,607
ASPHALT CONC. PAVEMENT CL. E	TON	$30	75,585	$2,267,556	150247	$4,507,402
Structure						
REMOVE EXISTING BRIDGES	SF	$25	94296	$2,357,400	94,296	$2,357,400
WIDENING OF RR BRIDGE (MP 77.12)	SF	$100	9552	$955,200	9,552	$955,200
RR BRIDGE (MP77.51)	SF	$100	60600	$6,060,000	62,040	$6,204,000
13TH STREET BRIDGE	SF	$100	5648	$564,800	6,032	$603,200
DILLENBAUGH CREEK BRIDGE	S.F.	$100	19440	$1,944,000	20,880	$2,088,000
DILLENBAUGH CREEK - NB OFF RAMP BRIDGE	S.F.	$100	7072	$707,200	7,696	$769,600
DILLENBAUGH CREEK - SB ON RAMP BRIDGE	S.F.	$100	7072	$707,200	7,696	$769,600
SR 6 BRIDGE	S.F.	$100	13054	$1,305,400	15,372	$1,537,200
WEST STREET BRIDGE	S.F.	$100	5248	$524,800	6,400	$640,000
NATIONAL AVENUE BRIDGE	S.F.	$100	5904	$590,400	6,288	$628,800
SALZER CREEK BRIDGE	S.F.	$100	16800	$1,680,000	18,240	$1,824,000
MSE WALLS	S.Y.	$250	8,754	$2,188,399	15,172	$3,792,986
GRAVEL BACKFILL FOR WALLS	CY	$20	9,915	$198,298	24,811	$496,218
TEMPORARY WALLS	S.Y.	$100	0	$0	10,733	$1,073,333
Drainage						
SCHEDULE A STORM SEWER PIPE 36 IN. DIAM	LF	$35	26,000	$910,000	26,000	$910,000
SCHEDULE A STORM SEWER PIPE 24 IN. DIAM	LF	$25	39,000	$975,000	39,000	$975,000
SCHEDULE A STORM SEWER PIPE 18 IN. DIAM	LF	$20	6,933	$138,667	6,933	$138,667
CATCH BASIN TYPE 1	EACH	$900	173	$156,000	173	$156,000
DITCH SYSTEM	LF	$5	52,000	$260,000	52,000	$260,000
STORMWATER TREATMENT FACILITIES	LS	$1	500,000	$500,000	500,000	$500,000
Traffic						
ILLUMINATION, SIGNING, AND IT	LS	$1	1,150,000	$1,150,000	1,150,000	$1,150,000
TRAFFIC SIGNALS	LS	$1	1,850,000	$1,850,000	1,850,000	$1,850,000
SINGLE SLOPE CONCRETE BARRIER	LF	$45	26,000	$1,170,000	26,000	$1,170,000
TEMPORARY BARRIER	LF	$12	52,000	$624,000	156,000	$1,872,000
REMOVING AND RESTTING BARRIER	LF	$4	208,000	$832,000	624,000	$2,496,000
GUARDRAIL	L.S.	$1	115,000	$115,000	155,000	$155,000
MEDIAN BARRIER	LF	$25	9,500	$237,500	35,000	$875,000
TRAFFIC CONTROL	L.S.	$1	2,467,600	$2,467,600	3,457,600	$3,457,600
Other						
WETLAND MITIGATION	ACRE	$100,000	72	$7,177,410	100	$10,027,548
MISCELLANEOUS (25%)	L.S.	$1	12,760,498	$12,760,498	18,587,235	$18,587,235

TOTAL 1	**$ 63,802,489**	**$ 92,936,174**
MOBILIZATION (10%)	$ 6,380,249	$ 9,293,617
TOTAL 2	**$ 70,182,737**	**$ 102,229,792**
SALES TAX (7.6%)	$ 5,333,888	$ 7,769,464
ENGINEERING AND CONTINGENCIES (15%)	$ 10,527,411	$ 15,334,469
RIGHT OF WAY	$ 2,000,000	$ 3,000,000
TOTAL 3	**$ 88,044,036**	**$ 128,333,724**
PRELIMINARY ENGINEERING (10%)	$ 8,804,404	$ 12,833,372
FINAL TOTAL	**$ 96,848,440**	**$ 141,167,097**

COST Δ (raise vs. no raise)= $44,318,657

Letter from Washington State Department of Transportation

Washington State
Department of Transportation
Douglas B. MacDonald
Secretary of Transportation

Southwest Region
11018 Northeast 51st Circle
P.O. Box 1709
Vancouver, WA 98668-1709

360-905-2000
Fax 360-905-2222
TTY: 1-800-833-6388
www.wsdot.wa.gov

December 5, 2001

Beth Coffey, P.E.
Seattle District Corps of Engineers
Planning Branch
PO Box 3755
Seattle, WA 98124

Dear Ms. Coffey:

The purpose of this letter is to communicate the Washington State Department of Transportation's (WSDOT) intentions of addressing safety and capacity needs on Interstate 5 in the Corps Centralia Washington Flood Damage Reduction Study Area. WSDOT intends to address the flooding of the Interstate before we go forward with a major capacity or safety project. This direction is in accordance with Federal and State laws and rules.

The WSDOT has prepared a New Law Budget (NLB) for the 2002 State Legislative session. We have included the widening of Interstate 5 from Rush Road to Ground Mound Interchange (milepost 72 to 88) in this budget. This includes funds to address the safety, capacity and flooding problems on this section of the Interstate. This is a ten-year budget proposal.

The Record of Decision (ROD) for the Environmental Impact Statement for the I-5 corridor including the action within your study area has not yet been issued. The Federal Highway Administration is consulting with the Environmental Protection Agencies on a few outstanding items. Once the ROD is issued, the WSDOT can begin project level environmental work.

If NLB funding for this project is approved next spring, we plan to begin right of way acquisition by 2005. We plan to begin construction on the first project by 2006 and complete construction on the last project by 2012.

I hope his letter adequately clarifies WSDOT's intentions on this issue.

Sincerely,

Bart S. Gernhart, P.E.
Project Development Manager

BSG:kd
Gernhart/Coffey I-5 @ MP 72 to 88